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the small systems journal

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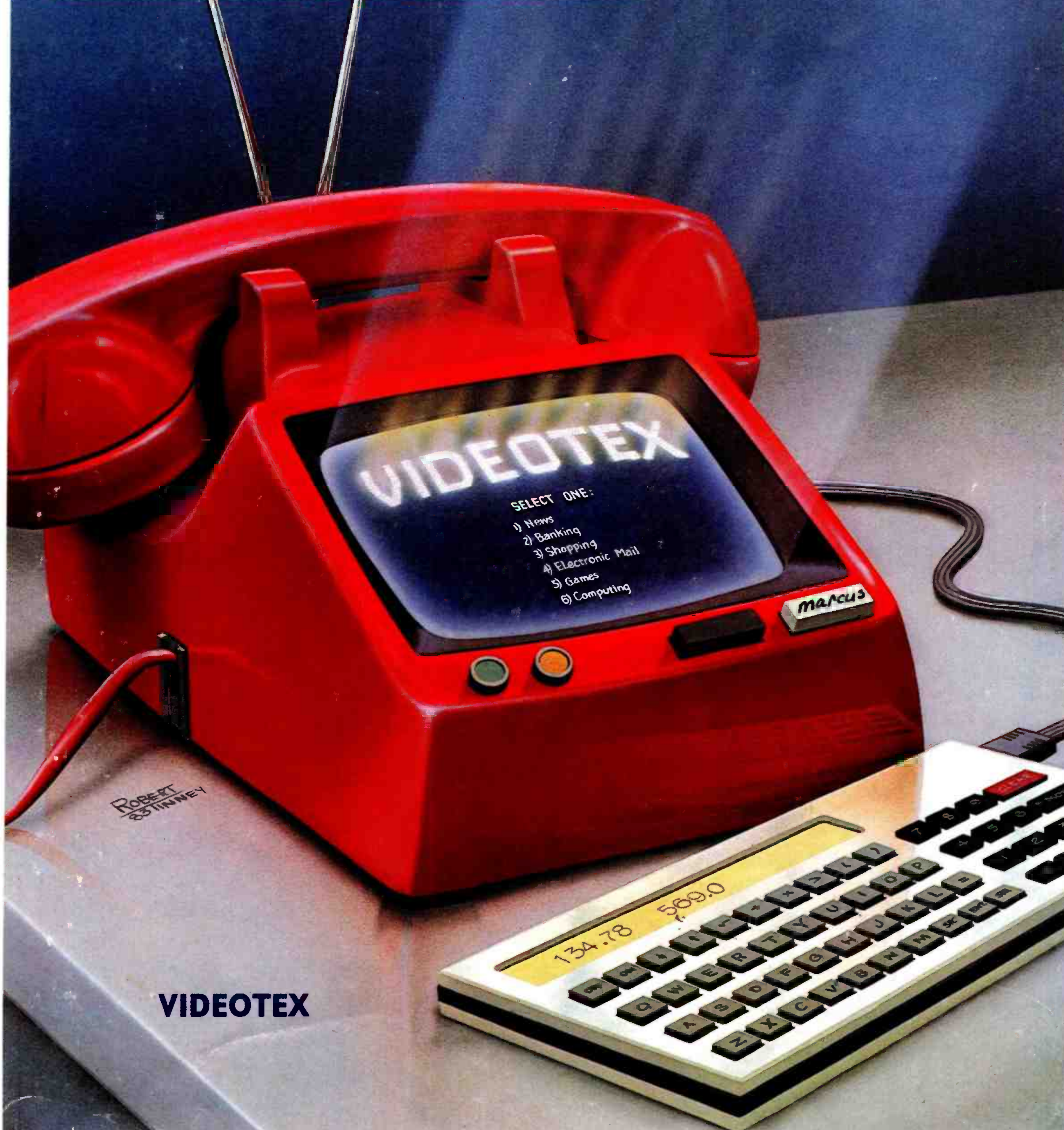


VIDEOTEX

Apple Computer Inc., 20525 Mariani Avenue, Cupertino, California 95014 Vol. 1 No. 2

For the authorized Apple dealer nearest you, call 800-538-9696 (800-662-9238 in California.)

Fruitful Connections.

There are more people in more places making more accessories and peripherals for Apples than for any other personal computer in the world.

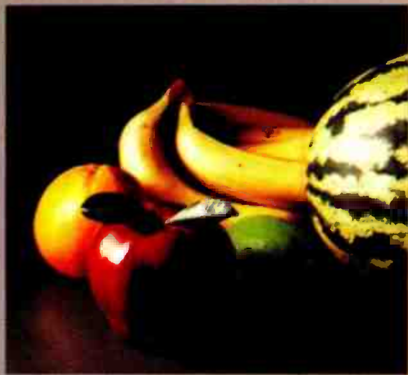
Thanks to those people — in hundreds of independent companies — you can make the humblest 1978 Apple II turn tricks that are still on IBM's Wish List for 1984.

But now we're coming out with our very own line of peripherals and accessories for Apple® Personal Computers.

For two very good reasons.

First, compatibility. We've created a totally kluge-free family of products designed to take full advantage of all the advantages built into every Apple.

Second, service and support.



Now the same kindly dealer who keeps your Apple PC in the pink can do the same competent job for your Apple hard-disk and your Apple daisywheel printer.

So if you're looking to expand the capabilities of your Apple II or III, remember:

Now you can add Apples to Apples.

A joy to behold.

The new Apple Joystick II is the ultimate hand control device for the Apple II.

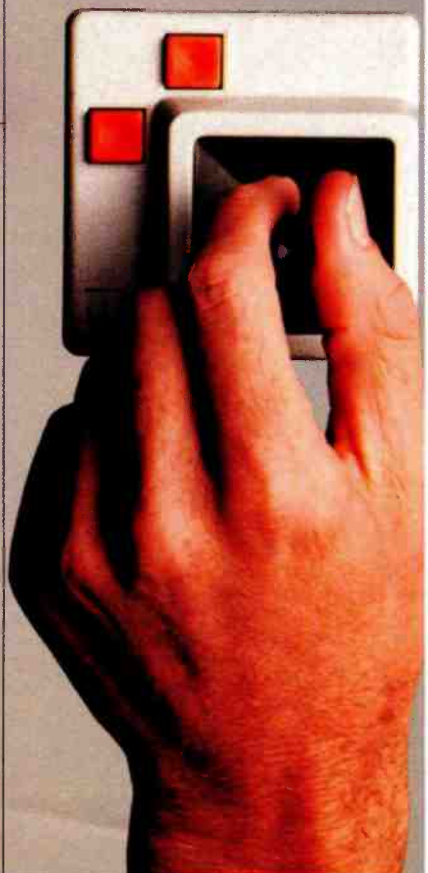
Why is it such a joy to use?

With two firing buttons, it's the first ambidextrous joystick — just as comfortable for lefties as righties.

Of course, it gives you 360° cursor control (not just 8-way like some game-oriented devices) and full X/Y coordinate control.

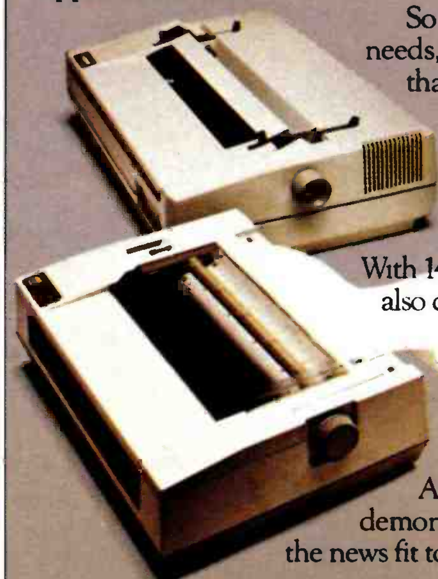
And the Joystick II contains high-quality components and switches tested to over 1,000,000 life cycles.

Which makes it a thing of beauty. And a joystick forever.



Gutenberg would be proud.

Old Faithful Silentype® has now been joined by New Faithfuls, the Apple Dot Matrix Printer and the Apple Letter Quality Printer.



So now, whatever your budget and your needs, you can hook your Apple to a printer that's specifically designed to take advantage of all the features built into your Apple. With no compromises.

The 7x9 Apple Dot Matrix Printer is redefining "correspondence quality" with exceptional legibility. With 144x160 dots per square inch, it can also create high resolution graphics.

The Apple Letter Quality Printer, which gets the words out about 33% faster than other daisywheel printers in its price range, also offers graphics capabilities. See your authorized Apple dealer for more information and demonstrations. Because, unfortunately, all the news fit to print simply doesn't fit.

Up the creek without a paddle?

Or lost in space? Or down in the dungeons?

Whatever your games, you'll be happy to know that someone has finally come out with game paddles built to hold up under blistering fire. Without giving you blisters.

Apple Hand Controller II game paddles were designed with one recent discovery in mind:

People playing games get excited and can squeeze very, very hard.

So we made the cases extra rugged. We used switches tested to 3,000,000 life cycles. We shaped them for holding hands and placed the firing button on the right rear side for maximum comfort.

So you'll never miss a shot.

A storehouse of knowledge.

If you work with so much data or so many programs that you find yourself shuffling diskettes constantly, you should take a look at Apple's ProFile,™ the personal mass storage system for the Apple III Personal Computer.

This Winchester-based 5-megabyte hard disk can handle as much data as 35 floppies. Even more important for some, it can access that data about 10-times faster than a standard floppy drive.

So now your Apple III can handle jobs once reserved for computers costing thousands more.

As for quality and reliability, you need only store one word of wisdom:

Apple.

Launching pad for numeric data.

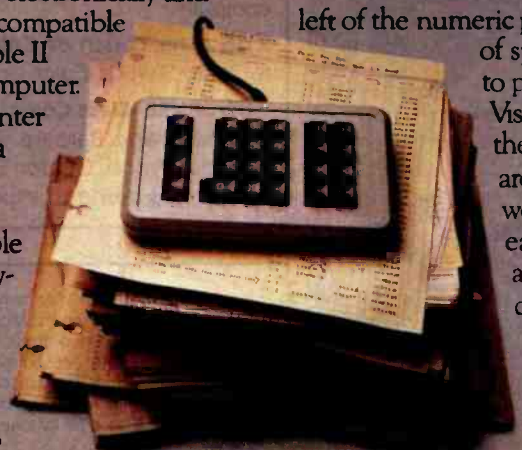
Good tidings for crunchers of numerous numbers:

Apple now offers a numeric keypad that's electronically and aesthetically compatible with the Apple II Personal Computer. So you can enter numeric data faster than ever before.

The Apple Numeric Keypad II has a standard calculator-style layout. Appropriate, because unlike some other keypads, it can actually function as a calculator.

The four function keys to the left of the numeric pad should be of special interest to people who use VisiCalc.® Because they let you zip around your work sheet more easily than ever, adding and deleting entries.

With one hand tied behind your back.



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Features

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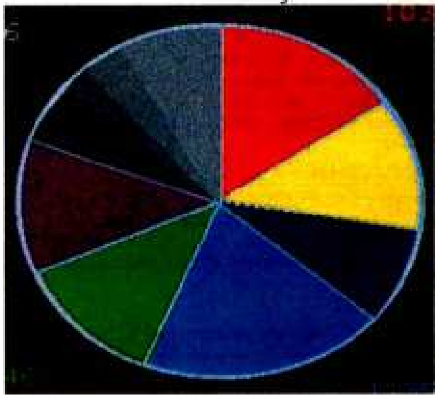
Reviews

Nucleus

Cover Painting by Robert Tinney



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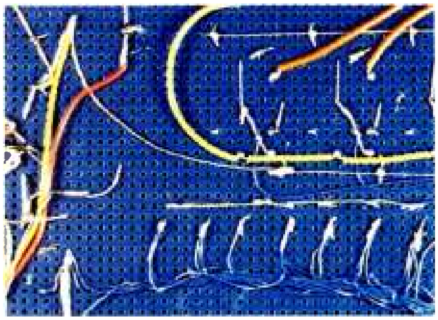

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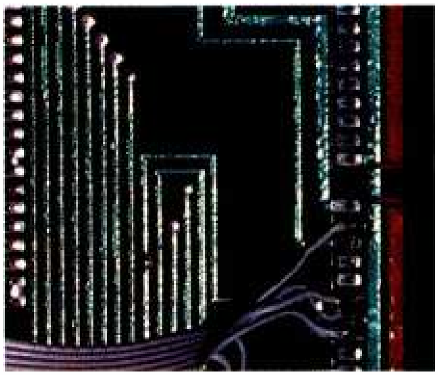

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Editorial

A Statement of Purpose

Lawrence J. Curran, Editor in Chief

BYTE's growth over the past seven years has paralleled the microcomputer's swift rise to prominence in the broad-based computer world. The foresight of the magazine's founders, who recognized that microcomputer pioneers wanted detailed technical information about hardware and software, enabled the magazine to establish itself as an authoritative voice in the personal computer arena. Today we are still committed to communicating detailed and technical information.

As the needs of the readers guided BYTE's founders, so do they guide us as we write and edit articles for a sophisticated audience that we believe comprises three principal segments: professionals in fields such as law, medicine, accounting, and business management who rely on computers as personal tools in their work; scientists and engineers in the computer industry who regard computers as essential development aids on the job; and those who use personal computers in nonvocational pursuits. We'll call those in the latter category hobbyists, although that term is subject to careful reexamination today.

BYTE's purpose will be to serve the technical information needs of that audience as it continues to grapple with myriad equipment and software choices. We intend to do that with a greater sense of urgency than BYTE has ever had. Some of the current speculation about BYTE suggests that it will become a news magazine. We do intend to offer departments in the magazine that treat late developments of interest to our audience. We introduced one of those last month. Called MICROBYTES (see page 7), it highlights industry events that will be treated in greater detail in subsequent issues. Be assured, however, that this new department, or others whose purpose is to present timely interpretation of industry events for computer users, will not tempt us to soften the detailed technical analysis of new products, technologies, and developments in computer science that BYTE has traditionally presented in its feature-length articles.

We intend to hire more editors and writers to gather and interpret information and to solicit technical articles from authorities in various disciplines within the microcomputer industry. We intend to bring you that information more quickly than ever before. We believe that adding some timeliness and urgency to BYTE's traditionally strong technical orientation will not make BYTE a news magazine. We have no intentions of diluting the magazine's technical content. If anything, we're committed to enriching that content through our own resources and those of McGraw-Hill Inc., the most highly respected publisher of technical information in the world. ■

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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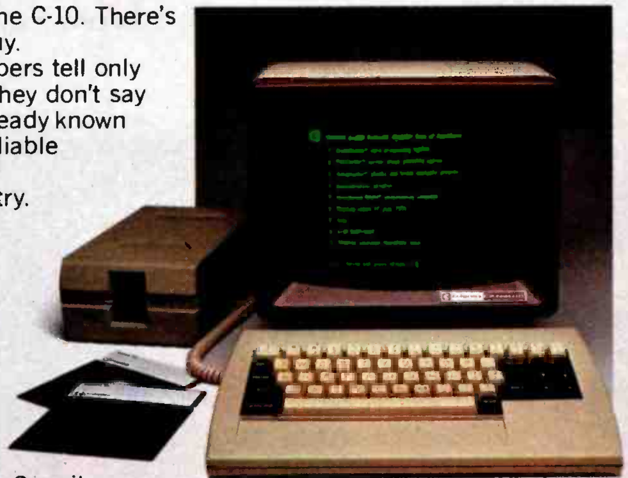

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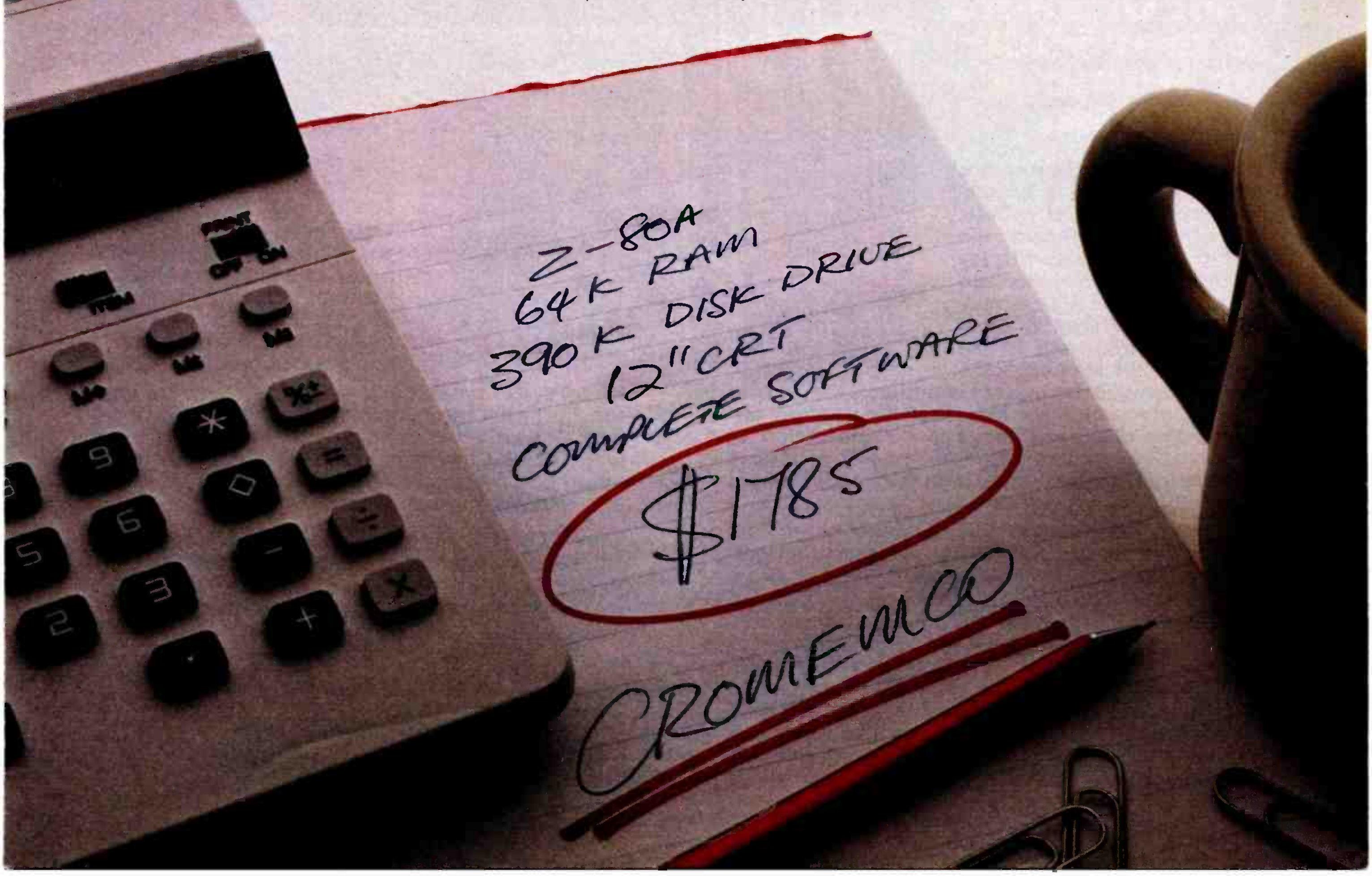

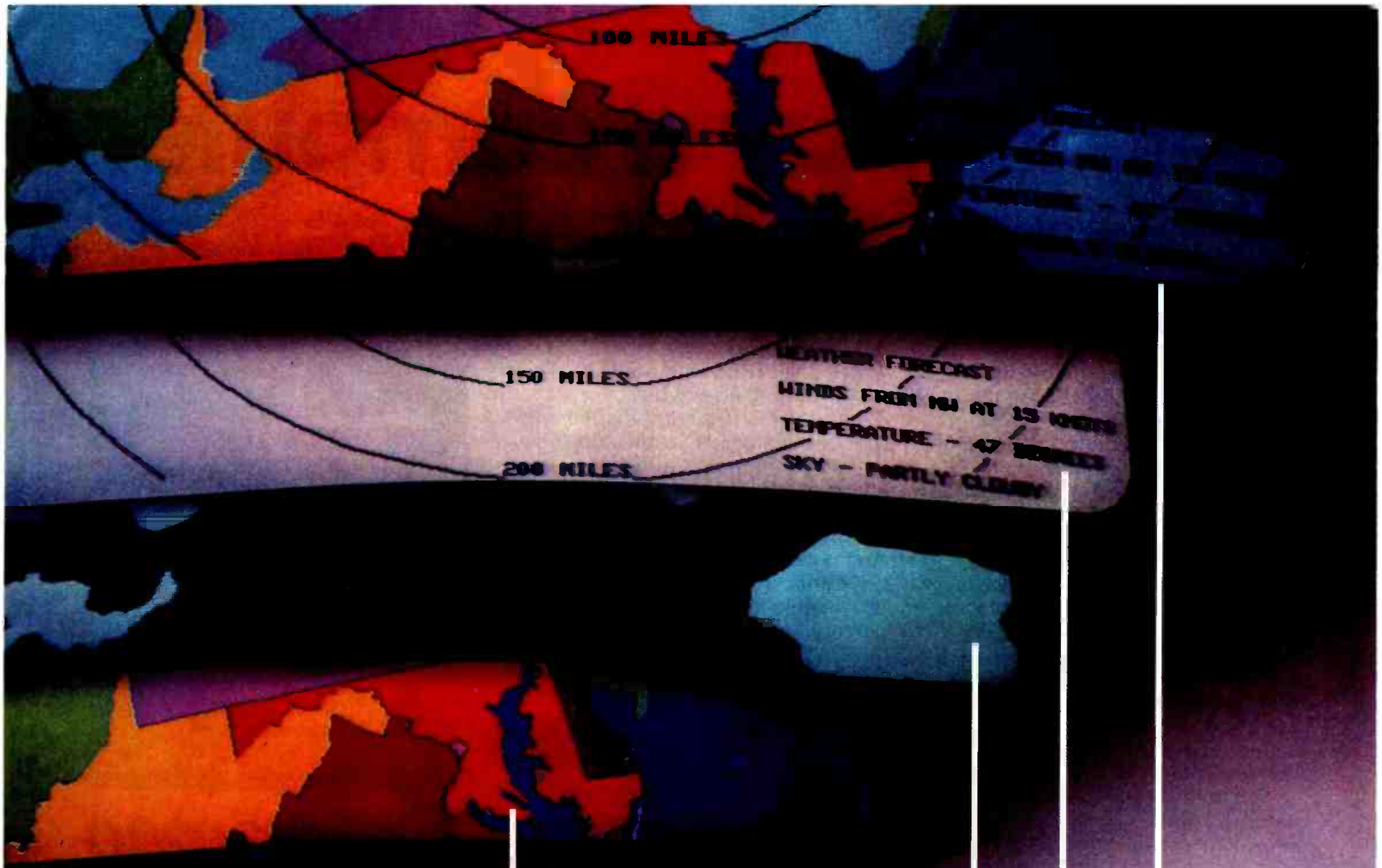

Add Multi-Transparency Color Graphics to Your S-100 or Multibus* System

The system builder's best choice for color graphics is a CS5000 color system from SCION. Its basic component is MicroAngelo®, the single board graphics display computer that has revolutionized monochrome display capability with low cost 512x480 pixel graphics resolution and 40 line by 85 character text capacity. When MicroAngelo boards are combined, they create high resolution color graphics that have a unique advantage. The displayed image is a combination of transparencies. So you can add, modify or delete images by transparency rather than as an entire image.

SCION's Series CS5000 builds an image with up to 8 bit planes, each generated by a MicroAngelo board. You select the assignment of those bit planes to transparencies. Each transparency can display 2^n-1 colors where n is the number of bit planes it uses... 2 bit planes would make a three color transparency, 8 bit planes would make a 255 color transparency. Once each transparency has been defined, your host can work with it independently, generating and modifying its graphics and text without interacting with the others. The independent transparencies are combined by the Color Mixer board which also assigns one of 16.8 million possible colors to each color of each transparency.

Your computer talks to the SCION Color System in SCREENWARE™, SCION's high level display firmware language. SCREENWARE commands are used by the computer in each MicroAngelo bit plane to generate graphics and text primitives. User interface is made simple with prompted system set-up using SCION's ColorPak.

MicroAngelo based color graphics systems are easy to use. Just plug the boards into your Multibus or S-100 host. Or use the freestanding work station configuration with its RS-232 interface. In each case, you get high resolution color graphics for such a low price you can't afford to design your own.

Think SCION for your graphics display needs. Think MicroAngelo. Call us at (703) 476-6100.

System shown is a Model CS5050S
*A trademark of Intel Corp.

SCION

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MICROBYTES

Staff-written highlights of microcomputer-related developments from the National Computer Conference.

NEW SYSTEMS ABOUND AT THE NATIONAL COMPUTER CONFERENCE

Two makers of minis and mainframes displayed 16-bit microcomputers at the National Computer Conference. Honeywell's Microsystem 6/10 uses a proprietary 16-bit microprocessor but features a personal computing option that includes an 8086 processor and both MS-DOS and CP/M-86. A complete system with 512K bytes of memory, two 650K-byte disk drives, two serial ports, and the 8086 processor costs $6370. Configurations for NCR's Decision Mate V microcomputer range from an 8-bit processor with a monochrome display that sells for $2650 to a 16-bit processor with an RGB color monitor for about $3600. NCR is courting local computer outlet chains to distribute the new machines.

Sanyo introduced the MBC 550, an 8088-based personal computer that sells for $995 when equipped with 128K bytes of RAM, a 160K-byte floppy-disk drive, printer port, and word-processing and spreadsheet software. A color monitor is available for $495.

The M68 personal computer from Sord Computer of America, New York, NY, features two microprocessors: a 10-MHz 68000 and a 4-MHz Z80A. The system has two 5¼-inch, 1.2-megabyte floppy-disk drives, two RS-232C ports and one parallel printer port, and 256K bytes of RAM. As an 8-bit machine, the M68 can run CP/M software. With a color monitor and Sord's PIPS III spreadsheet/file manager software, the M68 will sell for $4895.

Visual Technology Inc., Tewksbury, MA, demonstrated the Visual 1050 personal computer. Listing for $2695, the system has both Z80A and 6502 processors, 800K bytes of disk storage, bit-mapped graphics, serial and parallel I/O, and applications programs.

Mitsubishi's 816 distributed resource system supports multiple users in a 1-megabit network configuration. The network nodes can have up to 768K bytes of RAM, local as well as shared mass storage, and optional 800 by 500 graphics resolution. The operating system is an extended version of MP/M-86.

Mad Computer Inc., Santa Clara, CA, maker of the MAD-1, a new machine based on the 80186, announced that it will offer a $400 software package that will include MS-DOS 2.0, the Multiplan spreadsheet program, the low-cost Wordvision word processor, and GW-BASIC. CP/M-86 and Peachtree Software's integrated accounting packages will be available as options. MAD-1 will sell for between $4000 and $6000.

Digilog Business Systems' entry-level business computer is capable of being expanded to five processors and 16 users. Based on the Intel 80186, the DBS 16 contains two disk drives, 256K to 512K bytes of RAM, and interface capacity for up to four workstations running CP/M-86 and MP/M-86. To add more than four workstations, Digilog offers an expansion chassis with up to four slave 80186 processors. The DBS 16 is priced at $3495; individual workstations start at $1095.

NEC announced significant price reductions for its Advanced Personal Computer, dropping prices on many options by as much as 40 percent. The price of the 10-megabyte hard disk, however, came down only $100, to $2698. New options include an 8087 board and the family of Digital Research languages.

THREE COMPANIES INTRODUCE PORTABLE COMPUTERS

Televideo displayed the Teletote I, a 64K-byte, Z80A portable machine with one double-sided double-density disk drive, two serial-communication ports, a mouse connector, and a 9-inch green-phosphor video screen. The machine is bundled with CP/M and word-processing, spreadsheet, and graphics software for $1499.

Columbia Data Products introduced the Columbia VP, an IBM-compatible portable. In a 30-pound box, this machine offers as much as 256K bytes of RAM and dual half-height 320K-byte floppy-disk drives. Bundled with applications from Perfect Software, the machine will retail for $2995.

Universal Data Inc., Clarkston, MI, is offering a 12-pound portable computer that can run for two days on battery power. The UDI-500 has dual microfloppy disk drives, an 8-bit processor running CP/M, and word-processing, spreadsheet, and BASIC software. The system sells for less than $4000.

Otrona announced Attache S, a single-drive system that sells for $2695, and dropped the price of its Attache portable computer by $1000, to $2995. Both systems come with CP/M and five applications software packages.

STRIPPED-DOWN $495 COMPUTER IS IBM PC COMPATIBLE

Farrady Electronics, Palo Alto, CA, is shipping the FE Model 64, a single-board computer whose board and software are compatible with the IBM Personal Computer; the unit is $249 in OEM quantities and $495 in single quantities. The board contains an Intel 8088 processor, five expansion slots (four more slots can be added), two serial ports, one parallel port, and 64K bytes of memory (expandable to 256K). The user must provide power supply, keyboard, disk drive, and disk and video boards to complete the system.

FUJITSU DISPLAYS ENHANCED WORDSTAR FOR MICRO 16S

Fujitsu is offering an enhanced version of the popular word-processing program Wordstar with its new dual-processor microcomputer, the Fujitsu Micro 16s (see June, p. 150). This version of Wordstar features menus in color, user-definable function keys, and multitasking under Concurrent CP/M. The Micro 16s, with 8086 and Z80 processors, two floppy-disk drives, an RGB monitor, CP/M-86, Wordstar, and Supercalc, will sell for about $3995.

WESTERN ELECTRIC AND MICROSOFT ANNOUNCE NEW VERSIONS OF UNIX AND XENIX

The Western Electric division of AT&T announced that its new version of the Unix operating system, called System Five, will work with several powerful microprocessors, including Intel's 80286, Motorola's 68000, and National Semiconductor's 16032. Microsoft, which sells Xenix (a business-oriented version of Unix) and which is the largest licensee of Unix, responded by announcing that the company will incorporate Unix System Five's new enhancements into Xenix as soon as possible. Microsoft's version 3 of Xenix will be available soon for the Altos 586 and by November for the IBM PC. Because the entire Xenix package with all of its utility programs takes up about 8 megabytes, Microsoft has divided the system into modules. A single-user module will sell for $395. A multiuser module costs an additional $695. Two other modules can be added on top of the multiuser module: a system-development module for advanced programming work ($495) and a module for advanced text processing and typesetting ($395).

CP/M LICENSES COVER HEWLETT-PACKARD, XEROX, AND UDI MACHINES

Digital Research Inc., Pacific Grove, CA, used NCC to announce licenses with three microcomputer manufacturers for various versions of the CP/M operating system. One of the licensing agreements makes CP/M-68K available with Hewlett-Packard's HP Series 200 personal computers. CP/M-68K is a 16-bit version of CP/M that has been rewritten to take advantage of the power of the Motorola 68000, the 16/32-bit microprocessor used in all HP Series 200 computers. Digital Research views this contract as important because it's one of the first high-volume distribution agreements for CP/M-68K, which provides a bridge for transporting application software between Unix and CP/M systems.

Another licensing agreement enables Xerox Corp. to use CP/M and CP/M-86 on Xerox's 16/8 professional computer, which was introduced in early May. The 16/8 has both 8- and 16-bit microprocessors, each with separate memory, and the two versions of CP/M will allow users to perform separate operations simultaneously. The last of the Digital Research licensing agreements is with Universal Data Inc., Clarkston, MI, and provides CP/M for the UDI-500 8-bit portable computer, which was also announced at NCC.

NETWORKING AND WINDOWS FOR THE IBM PC

3Com Corporation, Xerox, and Visicorp have embarked on a joint project that will allow IBM PCs that are interconnected via 3Com's Ethernet interface and running Visi On to exchange electronic mail and to access Xerox laser printers and file servers. Xerox will design the print/filing/mailing module, and Visicorp and 3Com will market it. In addition to allowing electronic mail with Visi On-based applications, this product will enable IBM PCs in the office to be used with other Ethernet-based office equipment. In a related announcement, Xerox pledged that it would work closely with Visicorp to develop Visi On for Xerox's personal computers.

In yet another network offering, Davong Systems introduced Multilink, which enables up to 255 IBM PC or XT users to share hard-disk resources. Using a data-transfer rate of 2.5 megabits per second, this network is based on ARCNET levels 1 and 2. The network interface consists of a network transceiver, a local-network controller, a data buffer, a host interface, and ROM. The interface card for each node is $595 and requires 128K bytes per node. The networking software sells for $500. The maximum

Continued on page 296

Letters

Sounding Off for the PC

I am one of those quiet, ordinary computer professionals who buys BYTE every month. I also happen to be one of more than 200,000 IBM Personal Computer owners. I understand that you can't address every type of system every month or even every other month, so I don't get too upset at the lack of coverage of the IBM PC.

However, last month I read Gregg Williams' "The Lisa Computer System" (February, p. 33), which attempted to show how much better a machine it is than the PC. I cannot hold my tongue any longer. Just to point out the bias, you mentioned that when the two machines were comparably equipped, the PC very quickly ran out of slots. While this is true if you use all IBM products, it is certainly not true if you use multifunction cards such as Quadram or AST. Most of the people I know have done exactly that and have been quite pleased.

So what happens? IBM announces the PC-XT, a host of interconnects, a new operating system, etc. What does BYTE print? Zero! Nothing! An article on the new Intel chips is as close as you came to printing anything related to the PC. I guess I must be buying the wrong magazine. I dare you to print this letter and ask how many other readers out there feel the same way.

I'm not asking for top billing for the PC, just close to equal billing with the others. The Apples, S-100s, and others are all good machines, but so is the PC. I'd like to see a few comparisons done fairly.

William T. Manley
8345 Attica Ct.
Jonesboro, GA 30236

I hope you don't have the wrong impression about our interest in the IBM Personal Computer. By unhappy coincidence, your letter came just before our May issue, which contained a full-page announcement of the IBM PC-XT (p. 520), a construction article on the IBM PC keyboard (p. 402), and a review of four IBM PC word processors (p. 176). We plan to have other articles on the IBM PC, including a two-part article on interfacing the IBM PC to the Intel 8087 floating-point chip (the latter written by Tim Field, who did the excellent "A Peek into the IBM PC" in March).

*Regarding the Lisa article I wrote in February, I do not agree that my treatment of comparably equipped Lisa and IBM PC machines constitutes a bias on my part. I was aware that third-party multifunction boards could make IBM look better in that comparison, but the point was that the product as seen by IBM (i.e., using IBM products only) does run out of expansion room. I will change that opinion only when IBM introduces a multifunction board. . . .*G.W.

Portables Banned from Aircraft

The recent boom in portable computers has spawned a host of articles on the subject in recent months. Almost without fail, such letters refer to the fact that today's machines are portable in name only because they have either nonexistent or inadequate battery capability. These observations are most frequently followed by the comment that even those units with batteries lack the staying power for a coast-to-coast flight.

As both a manufacturer of computer systems and a pilot, I would like to call your attention to the fact that the operation of portable electronic devices aboard a commercial aircraft or an aircraft flying under instrument conditions is prohibited by law. (See Federal Aviation Regulations, Section 91.19.)

Computers are sources of EMI (electromagnetic interference), which can affect the navigational equipment aboard modern aircraft. This poses a clear hazard to the safety of the aircraft and its passengers.

Clearly, portable computers and airplanes do not mix. Nor is this restriction likely to be lifted in the near future. Although EMI can be reduced through shielding, it cannot be eliminated, and its effects can be cumulative. With most airline passengers flying for business purposes, the chance of multiple computer users on a given flight increases with the growing popularity of portables. Additionally, defects in wiring caused by either poor manufacture or physical shock (an increasing possibility with portables) can totally negate the effects of shielding. This would not necessarily affect the operation of the computer in any other way that might alert the operator to the situation.

Circle 212 on inquiry card. →

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It's no surprise so many businesses today are using our CompuStar* multi-user microcomputer. All sorts of businesses, those at the top and those on the way, know that only CompuStar can give them the big system performance they'll need as they grow. And they know that *only* CompuStar can deliver that performance at a fraction of the cost of most other systems.

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Whether you're a small business with big plans or a big business with an eye for economy, CompuStar* has the performance and versatility that's tough to outgrow . . . the price/performance ratio that's impossible to beat!

STANDARD FEATURES

- 350K/750K/1.5 MB workstation disk capacities
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CompuStar* is built and backed by the company that's been in the microcomputer business as long as microcomputers have been in business. Would you trust *your* business to anything less? CompuStar.* Tough to beat. Tough to outgrow!

*Microsoft is a trademark of Microsoft Corp.
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Manufacturers may advertise portables that will fit under an airplane seat. That is where they belong. If you feel compelled to work while flying, stick to pushing papers. Sit back and enjoy the flight.

Alexander Raue
Executive Vice-President
Elegant Solutions
3 Pleasant Valley Rd.
Whippany, NJ 07981

Don't Knock FORTH, C

I was pleased to see "Modula-2" by Joel McCormack and Richard Gleaves (April, p. 385), as I have been trying, with little success so far, to find out something about this alternative to Ada. It seems to be all that I hoped for. Although I like begin-end blocks better than if-end, while-end blocks, that's mainly due to my experience first with Pascal and then with C. Niklaus Wirth seems to have done an excellent job. Which brings me to the meat of my letter: the article is a good introduction to Modula-2, but it contained an unfair attack on the languages C and FORTH.

Hear me out. I am not an uncritical exponent of either language, especially not FORTH (although I don't know any other language that is as well suited to fast, efficient programming), but C certainly has the capability to clearly describe data structures and algorithms, detect program errors as syntax errors (although FORTH falls behind here, it certainly won't "quietly rearrange the meaning of the program"), and protect against improper mixing of different types (Pascal protects against even proper mixing of different types). If McCormack and Gleaves claim it can't, they don't know much about C. They certainly can't ever have programmed in C.

They also claim that C is "unreadable." Nothing could be farther from the truth. C is clean and lean, but hardly unreadable. I find it much more readable than Pascal, with its muddy structure. The authors' final slam on C, that it has "inadequate separate compilation features," is clearly untrue. The only way they could have gotten such an idea is by using (or hearing about) one of the hobbyist implementations of C.

Hoare was right: a language needs to be small enough that there is no need for subsets. It also needs to be large enough that there is no need for supersets. C (and probably, now, Modula-2) is a happy balance of small and large. I have never seen a superset (or even the need for a superset) of C. I have seen subsets of C and Pascal (and even, God forbid, BASIC), but these have been amateur compilers and interpreters designed purely for hobbyists. I have seen plenty of supersets of Pascal. In fact I have seen only one ISO standard, no-extensions Pascal. Nobody used it.

Extended Pascal is certainly not superior to C. It fails in power, elegance, and portability. McCormack and Gleaves should have presented Modula-2, which they clearly know well, to be judged on its own merits, rather than attack a language they seem to have little experience with.

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Belady's Algorithm Revisited

Because Stephen Schmitt's "Virtual Memory for Microcomputers" (April, p. 210) mentions L. A. Belady's algorithm, I would like to call your attention to the paper in which Belady presented many other algorithms (such as LRU) and the concept of locality of references for the first time: "A Study of Replacement Algorithms for a Virtual Storage Computer," *IBM Systems Journal*, Volume 5, Number 2, 1966, pp. 78-101.

R. J. Wilfinger
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La Grangeville, NY 12546

Formatting in FORTRAN

I really enjoyed the April Letters column (p. 12). It was a lively forum on what has grown into a multi-billion-dollar industry, the home computer business.

I first verified David Dunthorn's allegation (December 1982, p. 22) that Microsoft's FORTRAN 80 (version 3.41, created December 1980) would not correctly compile a format statement:

```
FORMAT(1X,3 F 10.2 / 1X,4 (F 10.4)
```

Instead of rescanning at the 'F 10.4' set of parentheses as the ANSI (American

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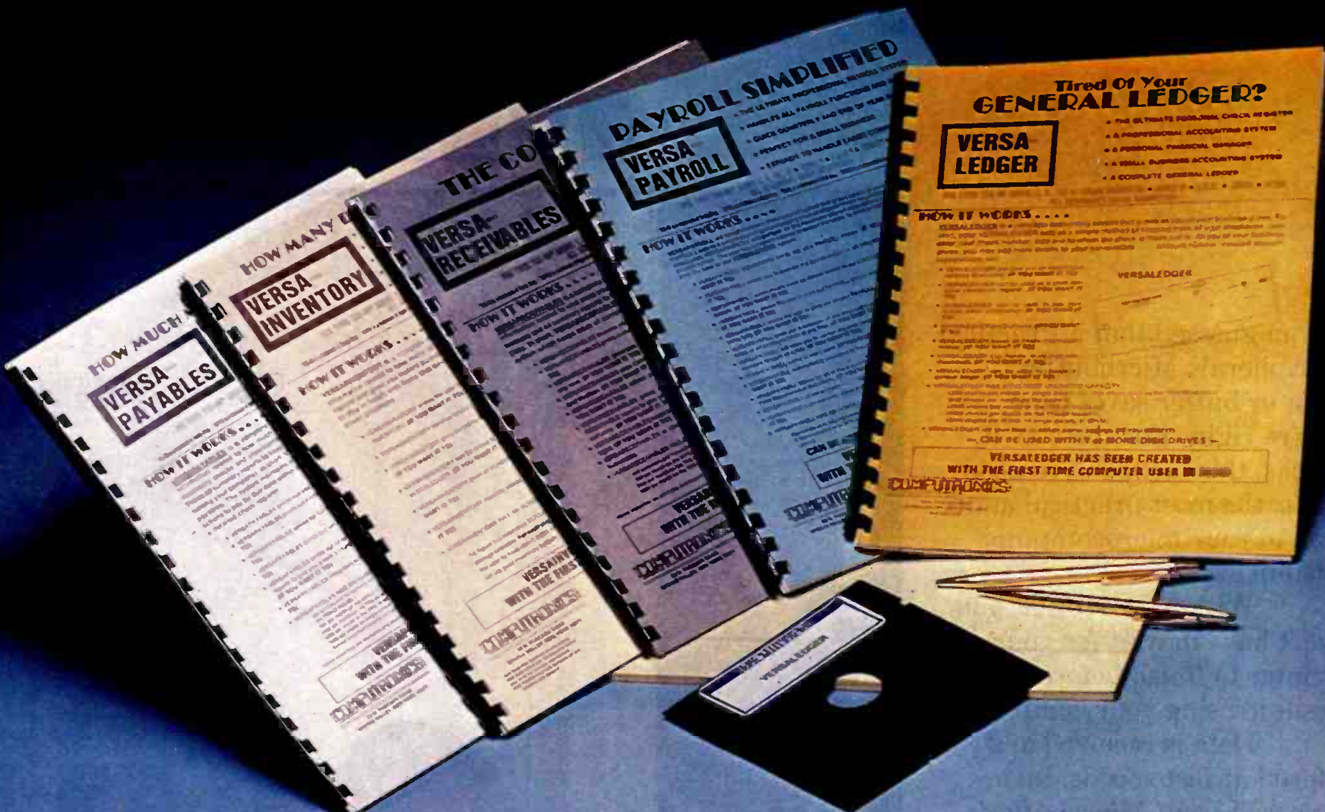

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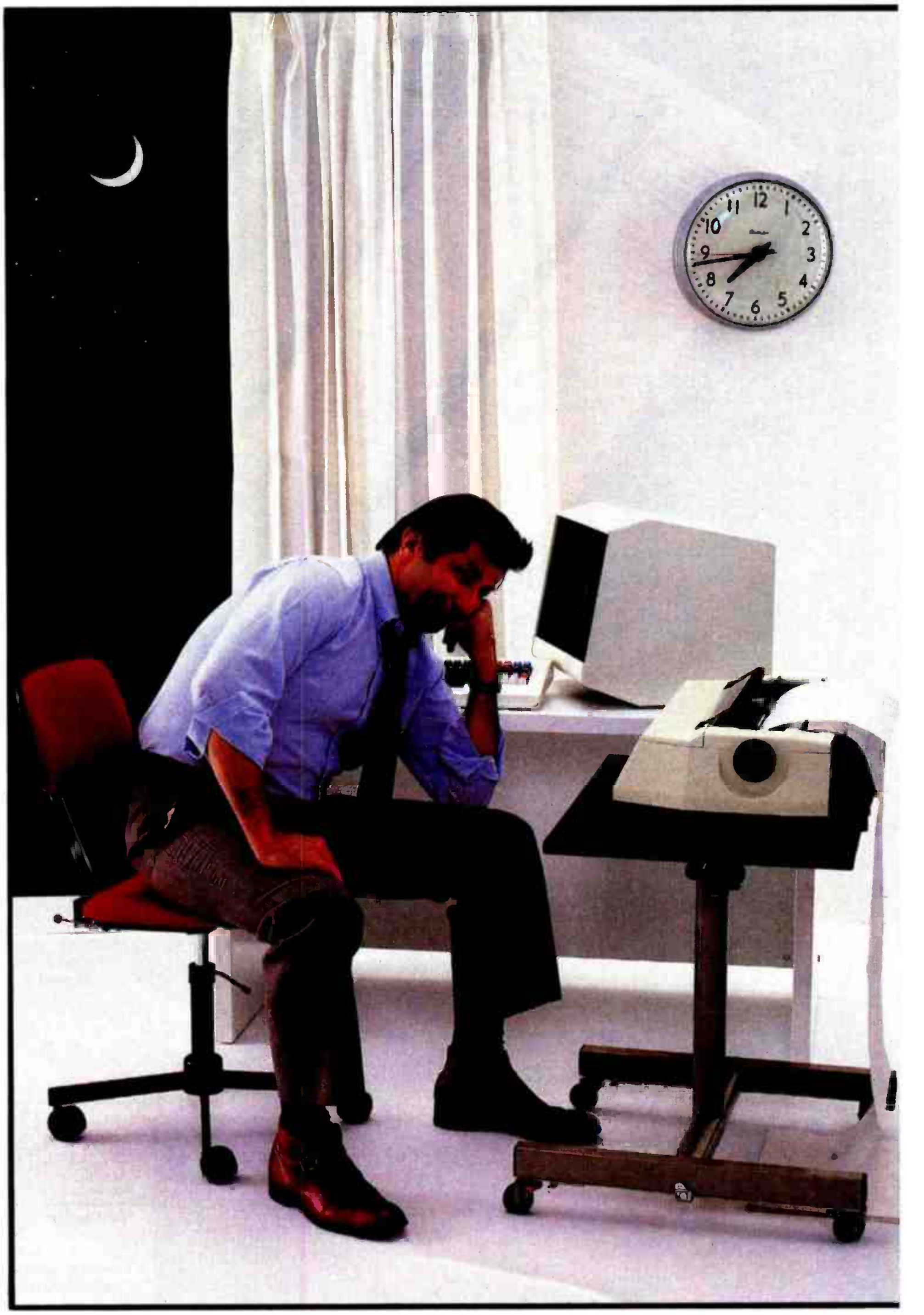

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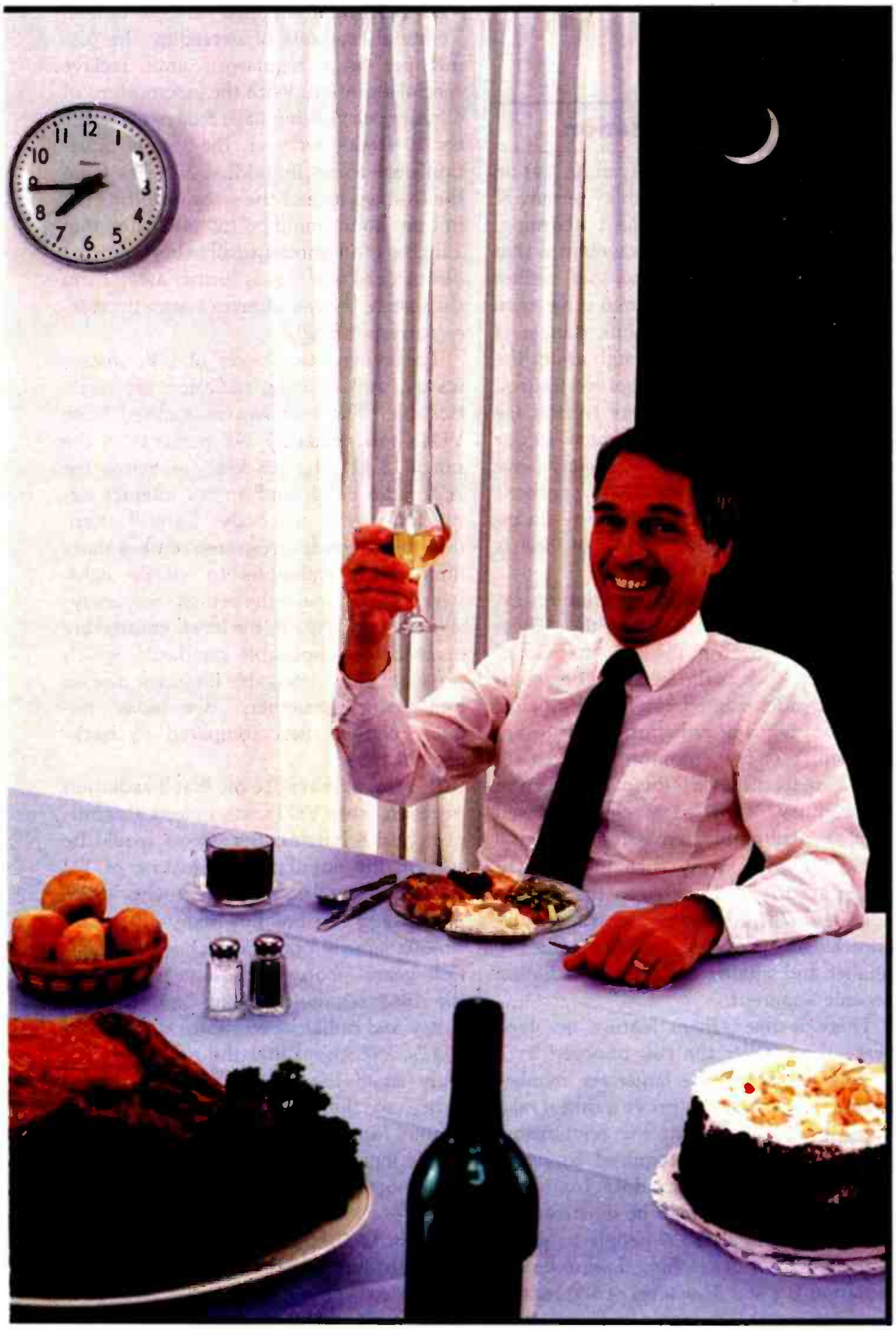

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National Standards Institute) standard said it should, it rescanned to '3 F 10.2 '. If there were 11 variables in the I/O (input/output) list, the first row should have three floating-point numbers with two decimal places and the second and third rows should have four floating-point numbers with four decimal places.

Old Microsoft didn't quite manage this! It gave a correct first and second row, but the third row had three numbers with two decimal places and the fourth had one number with four decimal places.

However, I'm not sure T. M. Putnam's criticism (December 1982, page 22) of the IBM Personal Computer FORTRAN compiler's handling of the CHARACTER data type is as valid. If a CHARACTER*64 data type is specified and the I/O list has fewer than 64 characters, a run-time error should occur. If, for example, the 64 characters in the I/O list form a sentence and the compiler accepts fewer than 64 characters, a logical error, loss in meaning, occurs. Pascal has a similar compiler error more cryptically stated:

175: Actual Parameter string length
less than var formal max length

To make things more confusing, Apple FORTRAN had no trouble with the rescan problem and will accept the CHARACTER * 64 data type. In this compiler a variable LINE, typed as CHARACTER*64 and confronted with an I/O list 10 characters in length, would be 10 characters; if the I/O list were more than 64 characters, variable LINE would be 64 characters.

Computer languages evolve, and meaning, form, and syntax change. I don't like Microsoft's handling of the FORMAT rescan function, but I cannot go along with Putnam's criticism of IBM PC FORTRAN. Microsoft is paranoid about the number of backup copies you make for your personal use and anxiously awaits the return of your serial number. It would seem, in fairness to the consumer, that a "bug" list, or discovered variations from ANSI standards, should be made available to registered purchasers of Microsoft products.

I use FORTRAN a good deal because most of the medical computers in radiology use the language. Many of these devices are under the jurisdiction of the FDA and the Bureau of Radiological Health. With the proliferation of microcomputers and programs in the hands of health-service professionals and physicians who use these products in patient care, it is possible to have a negligent software company on the wrong end of a multi-million-dollar malpractice suit. L. J. Kutten's elegant letter on "Disclaimers and the Law" (April, p. 22) should be required reading for the president of Microsoft.

Albert Weinshelbaum, M.D.
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Martinez, CA 94553

VDTs and Radiation

Edward Gogol's letter (April, p. 14) on the health risks of video display terminals' radiative emissions is indeed alarming. One of the aspects of his argument is that he would like actual exposure values quoted so that he could make his own decisions relative to absolute danger. I submit that if he knew enough about the subject to assess risk from quoted figures, he would either know where to find the numbers or how to measure them. In our technologically advanced society, we must accept the fact that another's knowledge must be depended on—an individual cannot know everything there is to know.

The subject of risk from radiation exposure is fraught with difficulties. These difficulties stem from the facts that Gogol points out, such as the lack of a threshold. The first documented cases of biological risk from ionizing radiation began to appear in the few months immediately following its discovery (before the turn of the century). The early cases showed damage attributable to massive doses, and it did not take many such instances to assign a correlation between the irradiation and the damage. As time (and knowledge) progressed, effects due to smaller and smaller amounts of radiation became apparent.

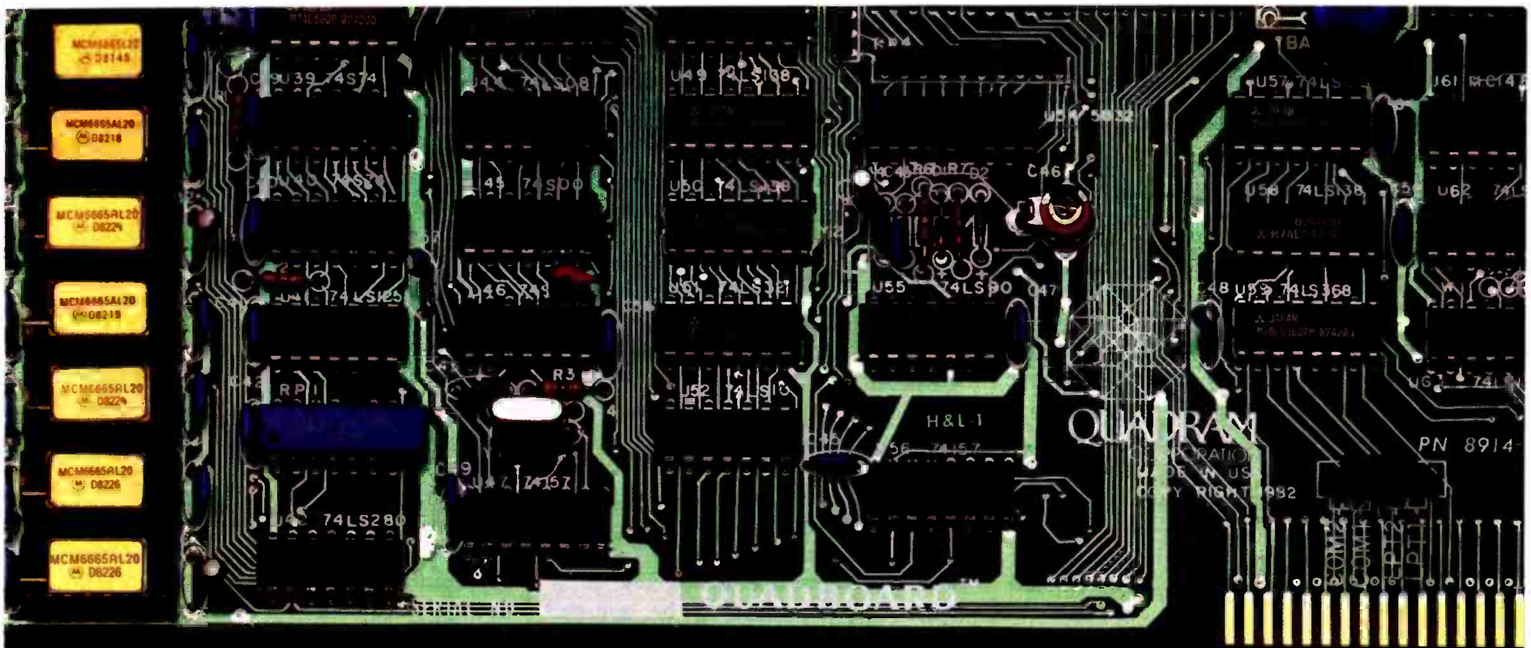
There is one salient feature involved here—the smaller the risk imposed by a perturbing factor, the larger the number of samples required to prove a causal relationship. The fact that the relationship between sample size required to prove causality and radiation dose follows a squared relationship can be illustrated as follows: if it takes 1000 people to prove that the risk of developing disease due to radiation is *x* at a dose level of 100 rads, it would take 100,000 people to demonstrate a risk at 10 rads. These numbers are only hypothetical, but at the radiation levels we can measure from VDTs, it is exceedingly unlikely that deleterious effects will ever be detectable, especially in view of background radiation levels and spontaneous disease rates.

To quote from FDA 81-8153, *An Evaluation of Radiation Emission from Video Display Terminals*, "For both normal and Phase III (worst-case) operating conditions, the likely emission from a VDT is 0.1 millirem (mR) per hour or less. Terminals capable of exceeding the 0.5-mR per hour regulatory limit receive special attention. With the assumptions of 6 hours per viewing day, 5 days per week for 50 weeks per year, the annual radiation dose to an individual 2 inches from the front surface of the screen emitting 0.1 mR per hour would be 150 mR. Note that 2 inches is an unrealistically short viewing distance; as one moves further away from the screen, the radiation exposure decreases correspondingly."

The synergistic effects of UV, microwaves, and ionizing radiation are questionable. The microwaves emitted from VDTs fall primarily (95 percent) in the range 15 kHz to 125 kHz, or below the AM radio band, and do not interact significantly with the body. Careful attention to the spectral response of phosphors limits their emissions to visible light, which should make the benefit/risk analysis very easy. Again, the levels emitted are much below applicable standards, which are sent below detectable limits for disease induction. Remember, "detectable" implies relative risks compared to background rates.

It seems apparent to me that if radiation exposure from VDTs was indeed a significant health hazard, the effects would be seen in the population consisting of TV station program directors, who have peered into not one but many (10 or 20) simultaneously operating screens for multiple years—many of those years prior to the 1968 regulations that limit the circuitry and radiative emissions of TVs and VDTs. We *know* that the risk is vanishingly small (based on our past experience), so the risk/benefit/cost analysis cannot favor any change that will even mildly increase the cost (i.e., lead screens, folded optics, LCDs, etc.).

Gregory L. Gibbs
Rocky Mountain Medical Physics Inc.
POB 27667
Denver, CO 80227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Fuzzier Than Intended

There are errors in the programs accompanying my article "Keywords in a Fuzzy Context" (March, p. 389). Line 182 in the program BIBBLD.BAS should read 'WORD$=LEFT$(WORD$,KWD.LEN%)' vice 'WORD$=LEFT$(WORD$,16)'. Without this change, the program will not work correctly for keywords with lengths other than 16 characters. A second error is present in the program VOCLST.BAS in line 6, which contains an extraneous variable, KWD, in the COMMON variable list. Line 6 should read

```
COMMON ISS.LEN%,CLS$,ERR%,
JOUR.LEN%,KWD.LEN%,CMD$(1)
```

With the error certain sequences of program operation will result in an inability to chain from the keyword listing function back to the main menu.

Thomas A. Smith
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Camarillo, CA 93010

Thomas Smith's "Keywords in a Fuzzy Context" was most interesting. However, his mathematical interpretations of the fuzzy operations seem to yield perhaps unintended results.

By defining the Boolean AND operation as the minimum of two values, Smith has created a function that emphasizes the smaller value and ignores the larger one. Consider the use of the AND operation as applied to the values of the corresponding keywords in the interrogation and the article descriptors. If an interrogation attribute was assigned a weight of 0.4 and a group of five articles with keyword values of 0.2, 0.4, 0.6, 0.8, and 1.0 were being considered, the results of the fuzzy AND would be 0.2, 0.4, 0.4, 0.4, and 0.4 respectively. Thus, rather than reflect a combination of the desired importance of an attribute and its value in an article, the AND operation limits the value of an article attribute to the keyword value, i.e., all articles with values greater than 0.4 will be evaluated equally and assigned a maximum result of 0.4. Why doesn't Smith use the arithmetic multiply function that would yield a more discriminating set of values: 0.08, 0.16, 0.24, 0.32, and 0.4?

A similar distortion occurs in the use of the OR operation, which is defined as the maximum of two values. Compare the results of (0.9 or 0.1) versus (0.8 or 0.8). Is the former pair, which yields a result of 0.9, really superior to the latter pair, which has a result of only 0.8? Note again the importance placed on one value in a pair, in this case the larger one, at the expense of ignORing all information about the smaller one.

The "maximum" function is equivalent to (1.0 × larger value + 0.0 × smaller value). To take into account the smaller value, the coefficients could be adjusted to perhaps 0.75 and 0.25. In the above example, this formula would yield 0.7 for (0.9 or 0.1) and 0.8 for (0.8 or 0.8). The values of the coefficients could be adjusted depending on the importance you assign to the larger value versus the smaller one.

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Storing Binary Numbers

There may be a better way to store numbers in binary floating-point form than the technique that you presented in "Binary-Format Numbers Storage on the Apple II Disk," (March, p. 453).

Why bother with the high-order bit? In fact, why call the DOS routine to put the data into the file buffer? Just move the 5-byte floating-point number to the buffer directly and update the byte offset in the file manager work area. When the buffer is full, call the DOS routine to output the buffer and reset the work area pointers.

In fact, many text files do not have the high-order bit on for each data byte in the file. These files do not follow the DOS convention, but they contain valid data nevertheless. Personal Finance Manager (Apple Special Delivery) uses a 281-sector text file for storing binary data (floating point, integer, and character values, all without the high-order bit on). A better technique would be to use BSAVE/BLOAD for binary data. This eliminates the program altogether.

Using your technique to store a 1000-element array would take four additional sectors of disk space (6000 bytes versus 5000 bytes in a binary file).

Ken Kashmarek
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In Support of Hackers

Contrary to Ron Dyer and Daniel Ross, (Letters column, February, pp. 26-27), I find Jerry Pournelle's column very enlightening and entertaining. A periodical that is very technically oriented needs Jerry's approach to journalism. I enjoy it so much that it's the first thing I read after "In the Queue." Pournelle tells it like it is in the real world. His "friends" add dimension, and the clubs and organizations add topic material and background.

Daniel Ross should come down from his pedestal and look around. I've worked in a software house for seven and a half years as a quality assurance analyst, and I'll take the so-called hacker any day to correct a bug report. The hacker's tools are intuition, imagination, and luck. The rate at which he or she can fix the bug and get the customer up and running again is what it's all about. All that top-down stuff is fine for new software development, but when the customer finds a bug and revenue isn't being generated, the hacker comes to the rescue.

No matter how much you preach and teach about flow charting or top-down design, they're long forgotten once the software is released. If it weren't for hackers, nothing would get done.

Larry Brown
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Dearborn Heights, MI 48127

A Vote for Pournelle

In reference to the attack on Jerry Pournelle in the February Letters column (p. 26), Dyer and Ross take themselves and microcomputing much too seriously. Keep the column just the way it is. I think that Jerry is much closer to the real world than either of these gentlemen. Those who are offended can very easily skip the User's Column.

Rodger B. Hallen
Regional Comm. Office
American Embassy–Manila
APO San Francisco, CA 96528

Tell Jerry Pournelle that I am with him 100 percent on his comment in the February User's Column (p. 364). Keep it

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31131 Via Colinas #607 • Westlake Village, CA 91362 • (213) 991-6210 • TLX 658233 (GENIE USA) a user's column. Tell me about things that can be bought and have been tested. Let somebody else write the language theorist's column.

I rather like seeing a little of the background behind the columnist's life. It makes the column seem more like a letter from a friend. And it helps to explain why "excellent" products that are hard to learn get such a chilly market reception; most people are too busy to spend the time learning them.

A reverence for clear thought is more the domain of the scientist/mathematician/theorist than the engineer. Those who solve real physical problems under time and expense constraints use many "cut and try" or "rule of thumb" approaches. Many practical real products are produced this way, and recombinant DNA and movies are prime examples, not counter-examples. Haven't Pournelle's critics ever heard of the "cutting rooms" in Hollywood?

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Canada

Revisiting the Next Generation

Timothy Stryker presented a proposal for a stack-oriented microprocessor that would directly implement in hardware the primary operations of a high-level language such as FORTH ("The Next Generation of Microprocessor," January, p. 128). However, as Stryker points out, this machine does not implement threaded code, and therefore it does not provide one of the most significant features of FORTH—extensibility of the operation set. In fact, implementing FORTH on this machine would require either an inner interpreter as in present-day implementations (the FORTH routine NEXT) to run FORTH code, which is very inefficient in terms of time, or in-line threading via explicit subroutine calls, which is inefficient in terms of space.

By making the following slight change in Stryker's scheme, it is possible to implement threaded code directly and efficiently in hardware (in fact, Stryker suggests a similar trick in his article, but for other purposes): the low-order bit of each machine instruction is used to distinguish between primary operations and user-defined extensions to the operation set. If this bit were set, the rest of the byte being examined would be decoded as an ordinary machine instruction to be executed directly by the hardware, but if the low-order bit was 0, this and the following byte would be treated as a 16-bit address of a subroutine to which an implicit CALL would be performed. With this architecture, a full version of FORTH can be implemented directly in machine language. User definitions would be compiled simply as subroutines. The double-indirect threading of today's FORTH is not needed because its main function (distinguishing between machine code and high-level code) is taken over by the hardware, and its other functions (e.g., for the definition of new operation types) can easily be achieved if there are instructions to directly access the subroutine return stack and its stack pointer. Moreover, in this new machine's FORTH, machine and high-level operations can be arbitrarily mixed. And in contrast to present-day FORTHs, operations in the primary word set require only 1 byte for each reference and no overhead in machine time; high-level operations require the same amount of memory but less time than at present.

The cost of this scheme is small—on average, ½ byte of memory for each user definition because definitions must begin at even addresses. Also, Stryker's abbreviated "PUSH a 16-bit constant" operation could no longer be implemented (i.e., a 16-bit PUSH would now always require 3 bytes of program space). However, PUSHes of constants above 16 or so make up only a very small part of a typical program.

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West Germany

Surpassing the 68000?

I read Chris Morgan's Product Description of IBM's 9000 (January, p. 100). Excellent article and to the point. Sounds like quite a product.

The article's last statement provides food for thought and speculation. "In one gesture, IBM has legitimized a microprocessor that deserves more attention. The Motorola 68000."

It would be interesting to know when IBM made the decision to use the 68000 in

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the 9000. Was the Intel 80286 available at the time? As of today (the 80286 became available in the fourth quarter of 1982), the 80286 will run rings around the 68000 on every score from speed to chip count. The 68000 won't come close in the C/Unix "microcomputer box" competition, for example. I think the 68000 has been surpassed.

Howard Boyet
14 E. 8th St.
New York, NY 10003

And More Pdkkdos. . .

It is my sad duty to inform you that the otherwise excellent letter from Chris Rudek (March, p. 22) contains a typographical error. The word "pokkdo" should actually be "pdkkdo."

It further annoys me that a ROM change is required to reconfigure the Osborne keyboard. This kind of executive paranoia is unjustifiable in light of the manifest availability of EAROMs, EEPROMs, etc. Why not permit users to reconfigure *ad libitum*? After all, the keyboard is detachable. When it becomes thoroughly discombobulated, they can always return it for refurbishing.

Jon Singer
Associate Engineer
Metamorphic Systems
4858 Sterling Dr.
Boulder, CO 80310

The Notion of Computer Literacy

I'd like to rebut E.J. Neiburger's letter (March, p. 16) scornfully decrying the need for computer literacy. The author shows more wit than insight.

Had the notion of computer literacy existed in the decades following the 1830s, it surely would have been pressed into service by the builders of railroads and other early products of the Industrial Revolution. The fact is that folks back then were just as leery of those machines as folks today are of computers.

Comparing computers to telephones or digital watches is misleading. Telephones came at the end of the Industrial Revolution, when the public was ready to accept—and expect—the "wonders of science." Nowadays we grow up with telephones and either don't give them a second thought or view them as indispensable tools of modern life—presumably the computer's future niche.

The computer literacy issue is a moot point. In two years or five the public will be computer literate by virtue of media overexposure and plain old familiarity—but what about those in the industry itself who write the documentation meant to clarify both hardware and software? Will they achieve literacy? I hope so, because my poor brain is wearing out from so much head scratching arising from puzzling over obtusely written manuals.

Sadja Herzog
6519 Fountain Ave.
Los Angeles, CA 90028■

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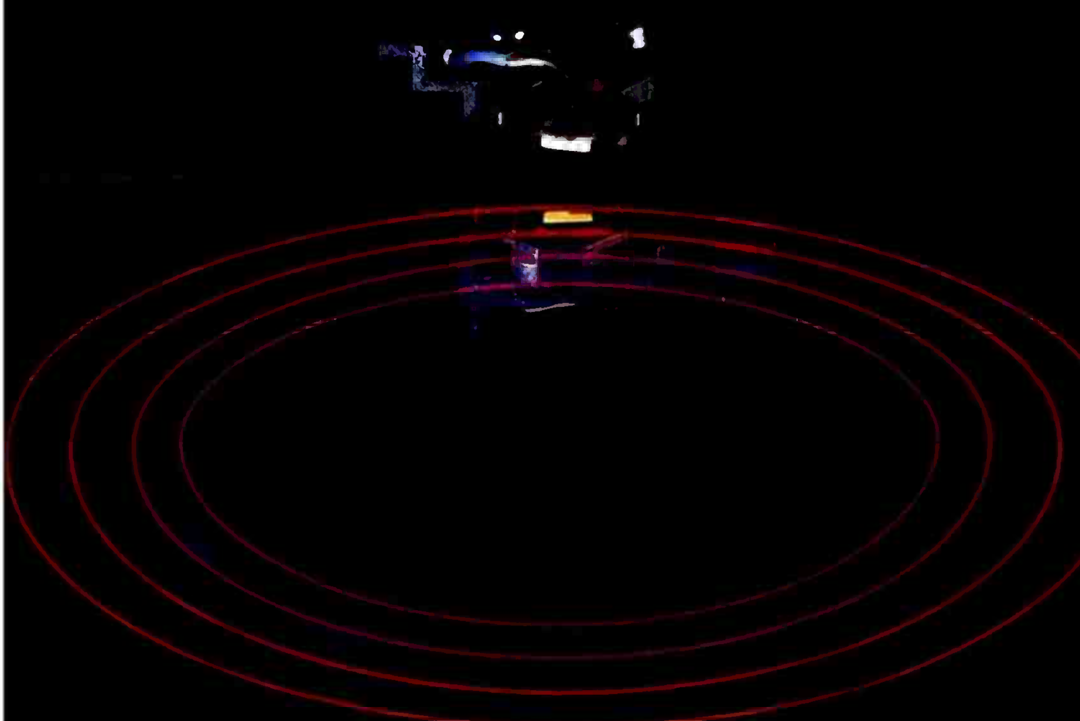

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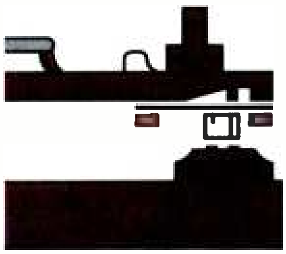

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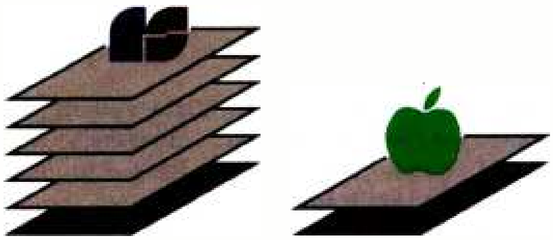

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Build the RTC-4 Real-Time Controller

A 4-bit single-chip microcomputer from Texas Instruments comes preprogrammed for timed automatic control.

by Steve Ciarcia

Bee-beep . . . bee-beep . . . bee-beep. I fumbled for the alarm button on my digital watch and briefly wondered what I had set it for.

"Oh yeah. Time to turn on the recorder."

The audio-cassette recorder in question was set up in one corner of the Circuit Cellar and connected to an FM radio. I had set it up to record a local news program, which is broadcast daily at 5:30 p.m. in my area. Because 5:30 is not usually a convenient time for me to listen to the radio, I often record the program so that I can listen to it later in the evening or the next day while I'm driving someplace.

So it was 5:28. Time to turn on the recorder. The trouble was I was outside working on my satellite dish antenna. As I dashed into the house and down the stairs, I thought, "There's got to be a better way to do this."

Once the recording was safely under way, I began to consider various automatic methods. I could use a mechanical timer, a simple digital alarm clock (with appropriate Circuit Cellar modifications), a BSR X-10 Home Control System timer, or my existing home-security and control system. None of these seemed completely satisfactory. Instead, I decided to look for a more universal solution.

The problem of timed activation pointed out the need for a generalized, cost-effective timer/controller that might, while solving my particular problem, have additional capabilities. As I was evaluating various circuits for real-time controllers, I came across some preprogrammed TMS1000-series 4-bit microcomputers-on-a-chip from Texas Instruments. One of these chips became the essential element in this month's project, the Circuit Cellar RTC-4 real-time controller.

The RTC-4 is a four-channel time-activated device or appliance controller that can be built for less than $100, complete with keypad, display, power supply, and relay outputs. It can be used in the home or laboratory for general time-dependent applications or, as in my case, to solve one particularly nagging problem.

Before jumping into how to build the RTC-4, let's take a look at the TMS1000 family tree and the particular branch of use in our project.

The TMS1000 Family

Texas Instruments (TI) makes a large family of single-chip MOS/LSI (metal-oxide semiconductor/large-scale integration) components called the TMS1000 series, which all contain 4-bit microprocessors. While the approximately 50 members of the family share a common subset of about 40 instructions, they differ in the varying amounts of read-only memory (ROM) and random-access read/write memory (RAM), and varying numbers of I/O- (input/output) control circuits. The family's members also differ in packaging and power requirements, but, in the 28-pin dual-inline package, the basic TMS1000 and TMS1100 are virtually the same with the exception of internal memory capacity. TI intends that the ROM in TMS1000-series components be mask-programmed for specific computing tasks; the devices are not general-purpose microprocessors, as are the familiar Z80, 6502, and 8088.

One major member of the product line is the TMS1100. This chip has 2048 bytes of internal ROM, 128 4-bit words (nybbles) of RAM, 4 input lines, and 19 output lines. (The basic TMS1000 contains less memory.) Figure 1 is a block diagram of its internal structure.

TMS1121C UTC

Somewhere on the 1100 branch of the TMS1000 family tree is an offshoot called the TMS1121C Universal

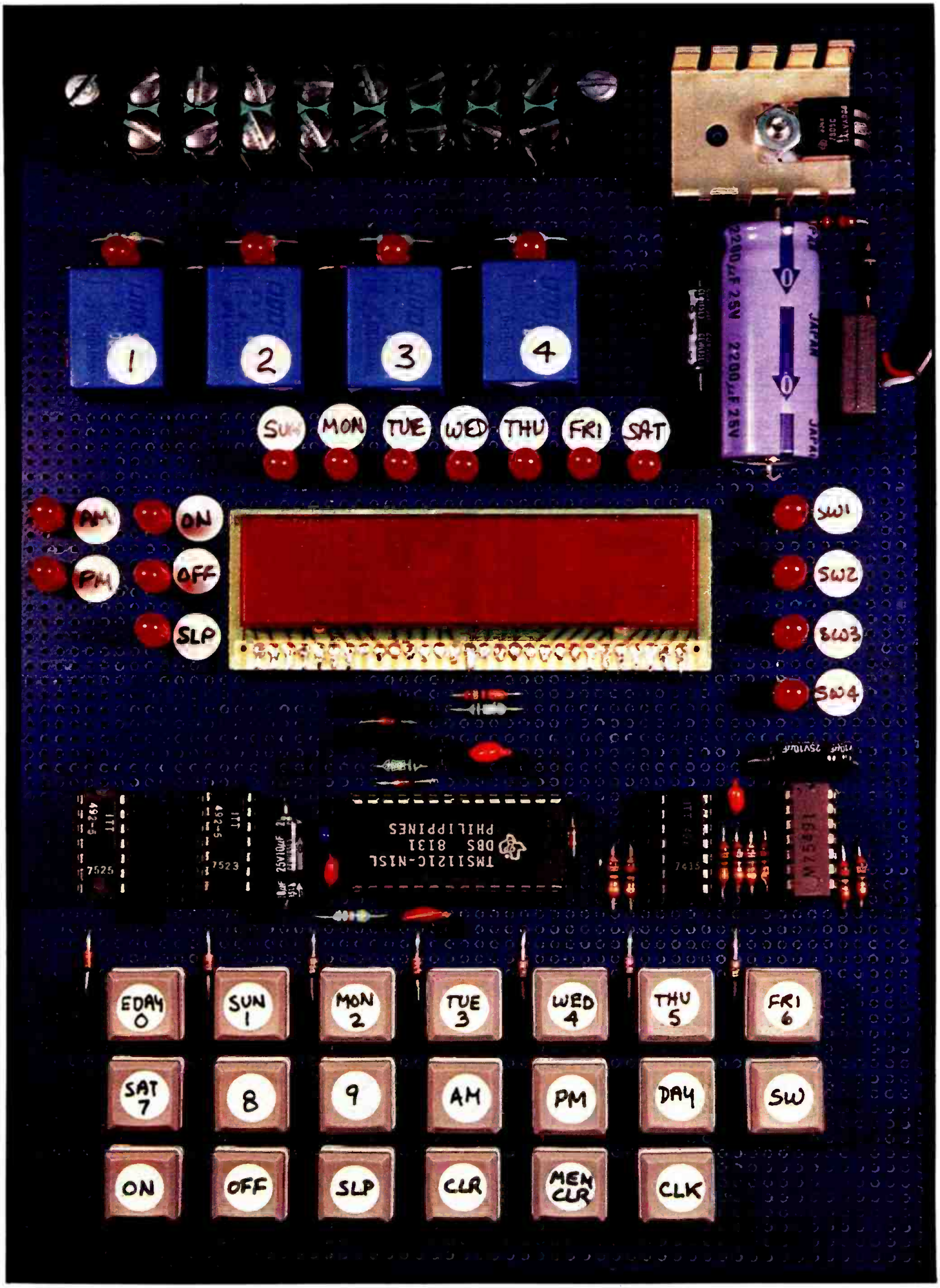
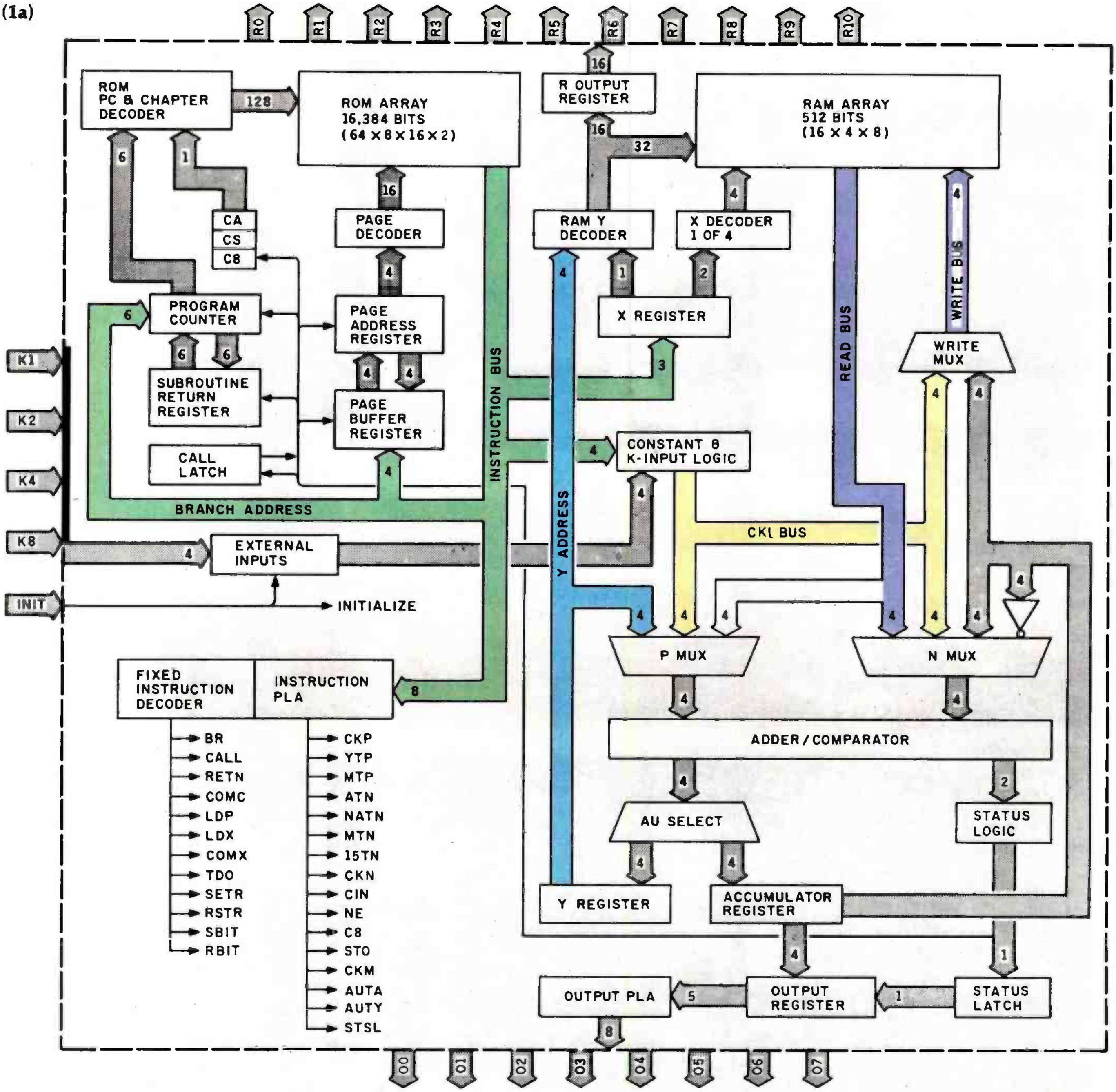


Photo 1: *Prototype of the Circuit Cellar RTC-4 real-time controller, a unit suitable for switching low-current external devices on and off according to immediate commands or stored time-lapse event settings.*

(1a)



(1b)

PIN NAME	*DESCRIPTION*	*TYPE*
K1, K2, K4, K8	DATA INPUT	INPUT
O0–O7	DATA OUTPUT	LIMITED CODE OUTPUT
R0–R10	CONTROL OUTPUT	OUTPUT
OSC1, OSC2	TIMING	INPUT (RC)
INIT	POWER ON RESET	INPUT

TMS1000
1024-BYTE ROM
64-NYBBLE RAM

TMS1100
2048-BYTE ROM
128-NYBBLE RAM

(1 NYBBLE = 4 BITS, 1 BYTE = 8 BITS)

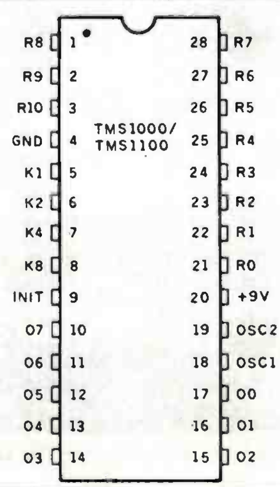


Figure 1: *The functional block diagram of the Texas Instruments TMS1100 4-bit single-chip microcomputers is shown in figure 1a. Figure 1b shows the pinout and I/O specifications of the TMS1000 series.*

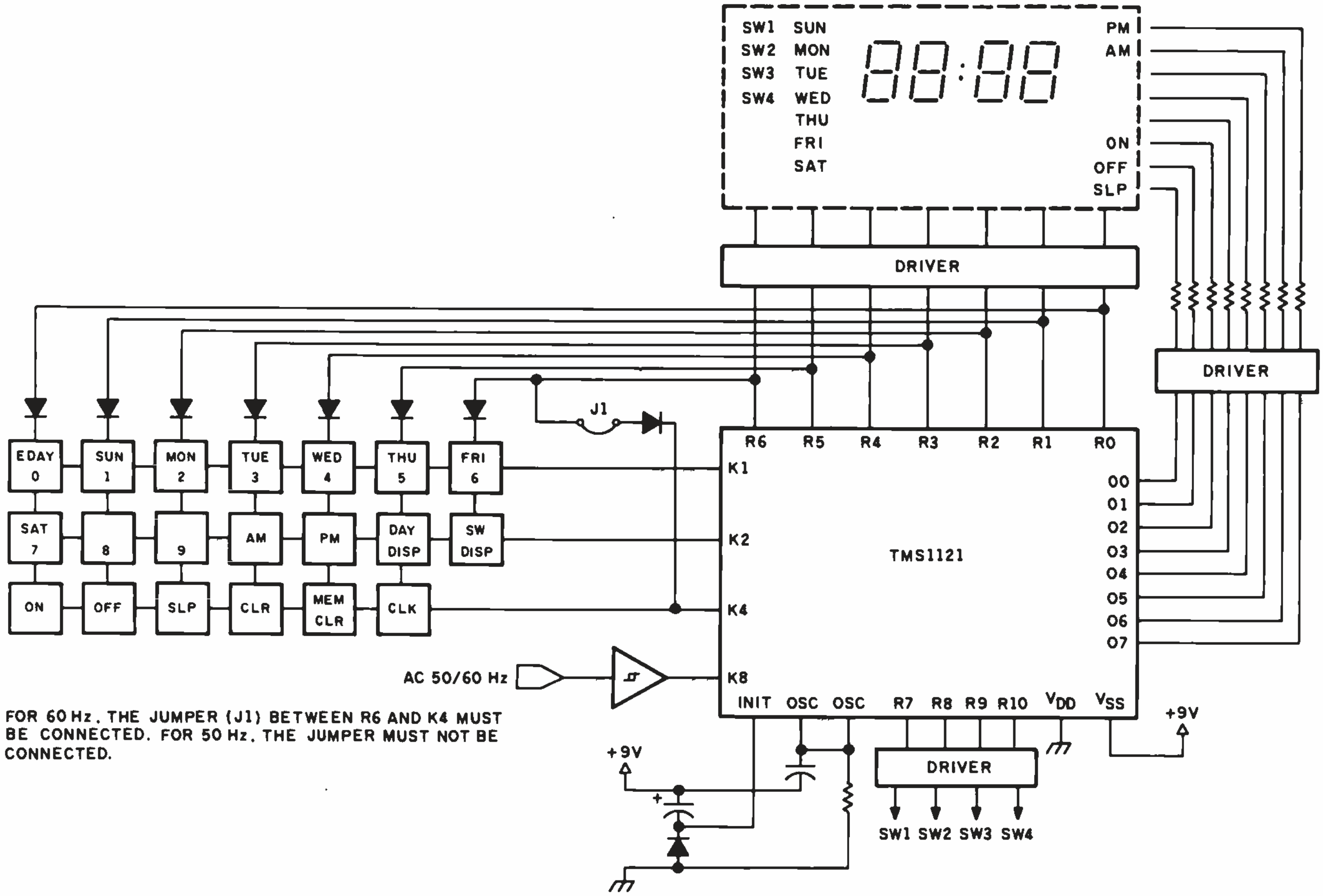


Figure 2: *Block diagram of the Circuit Cellar RTC-4 real-time controller, showing the TMS1121C 4-bit microcomputer and its associated user-interface components.*

Timer Controller. When I found out about the TMS1121C UTC, I realized that it was the perfect basis for the Circuit Cellar RTC-4 real-time controller. It is a variant of the 1100, designed and mask-programmed by Texas Instruments primarily to be a demonstration device for the TMS1000 product line. The 1121 is intended to provide a simple and inexpensive means for a prospective customer to become familiar with the workings of the 1000 series in an easily understood application that does not require costly custom programming. Fortunately for us, someone at TI did a little thinking and produced a rather neat (even considering its limitations) real-time programmable controller on a single chip.

RTC-4 Characteristics

The RTC-4 features a variety of control possibilities and operating aids: various status displays are available, many events can be programmed at once, and several options can be set up. Part of the RTC-4's task is merely to operate as a digital clock, displaying the time of day and the day of the week. The capabilities of the RTC-4 are essentially those of the TMS1121. A list of the unit's features is shown in table 1.

The RTC-4 contains additional circuitry necessary to interface the chip to the real world. In addition to the TMS1121, the unit includes an LED (light-emitting diode) display and associated drivers, a 20-key keypad, and four output relay switches.

The 20-key keypad enables you to enter instructions and data into the TMS1121. The instructions may be in the form of a stored program telling the RTC-4 what to do in the future, or they may be intended for immediate action. Using the pad, you can turn any of the output relays on or off directly without storing the commands in memory. Also, using the pad you can originate, change, inspect, or delete any timer programs.

The RTC-4 is capable of retaining up to 18 timer programs (on/off settings), which are entered through the keypad. Each of these programs can control one of the four output relay switches. The onboard output relays are small, low-current devices, so if

1. Four independent switch outputs with buffer
2. Display of time and day and status of its own switches
3. As many as 18 daily or weekly programmable setpoints
4. Memory display of programmed setpoints
5. Key entry for clock set and timer set
6. 50-Hz or 60-Hz operation

Table 1: *Capabilities of the RTC-4, which are essentially identical to those of the TMS1121C Universal Timer Controller.*

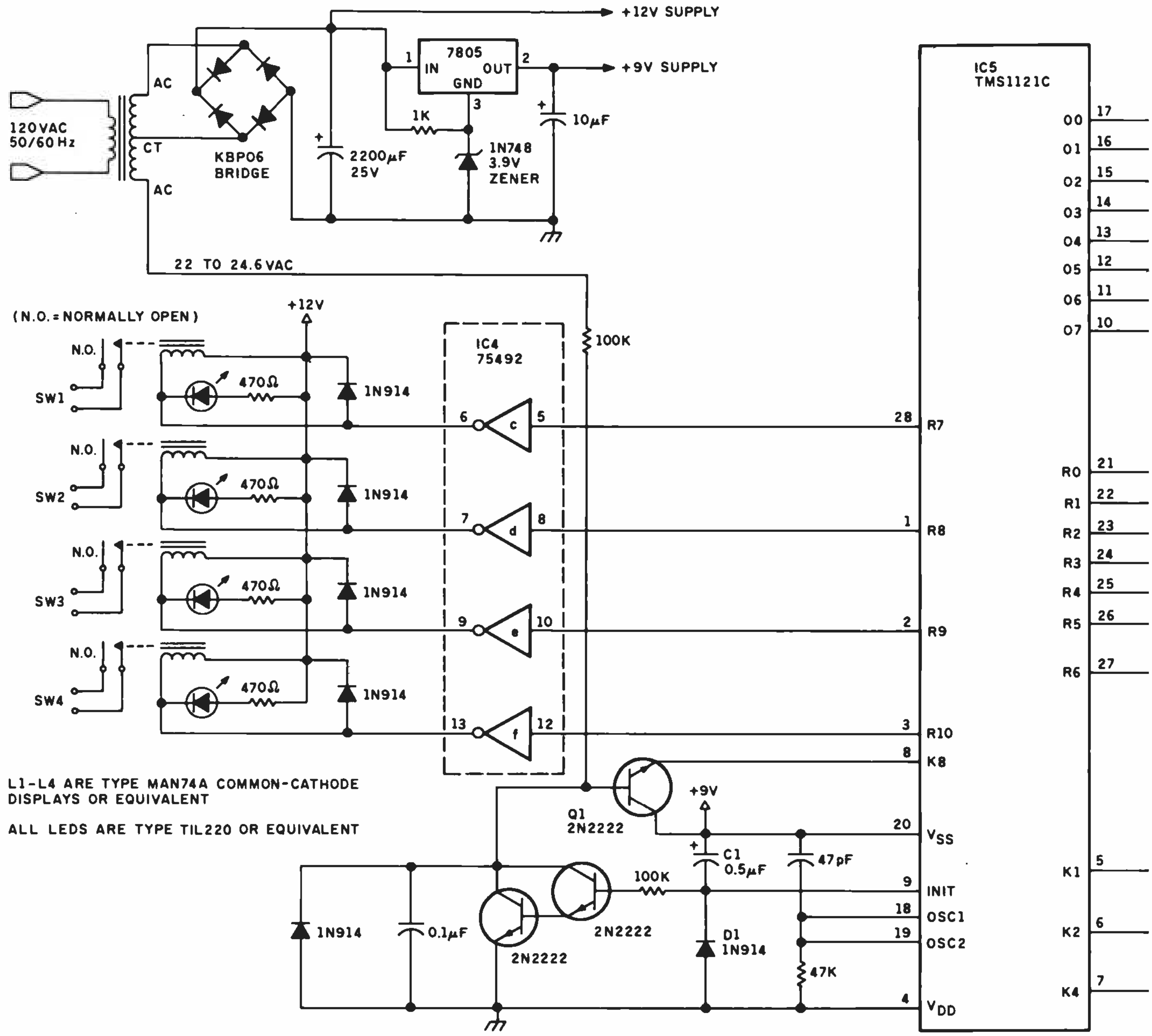


Figure 3: *Schematic diagram of the RTC-4. A type-MAN74A common-cathode LED display module is specified, a type somewhat different from the junk-box unit used in the prototype (see text box, page 34). Please note the position of the MSD (leftmost digit) and the LSD (rightmost digit) when wiring the unit.*

you want to control a toaster, you'll need to let the onboard relay control a larger outboard relay, which in turn operates the high-current device.

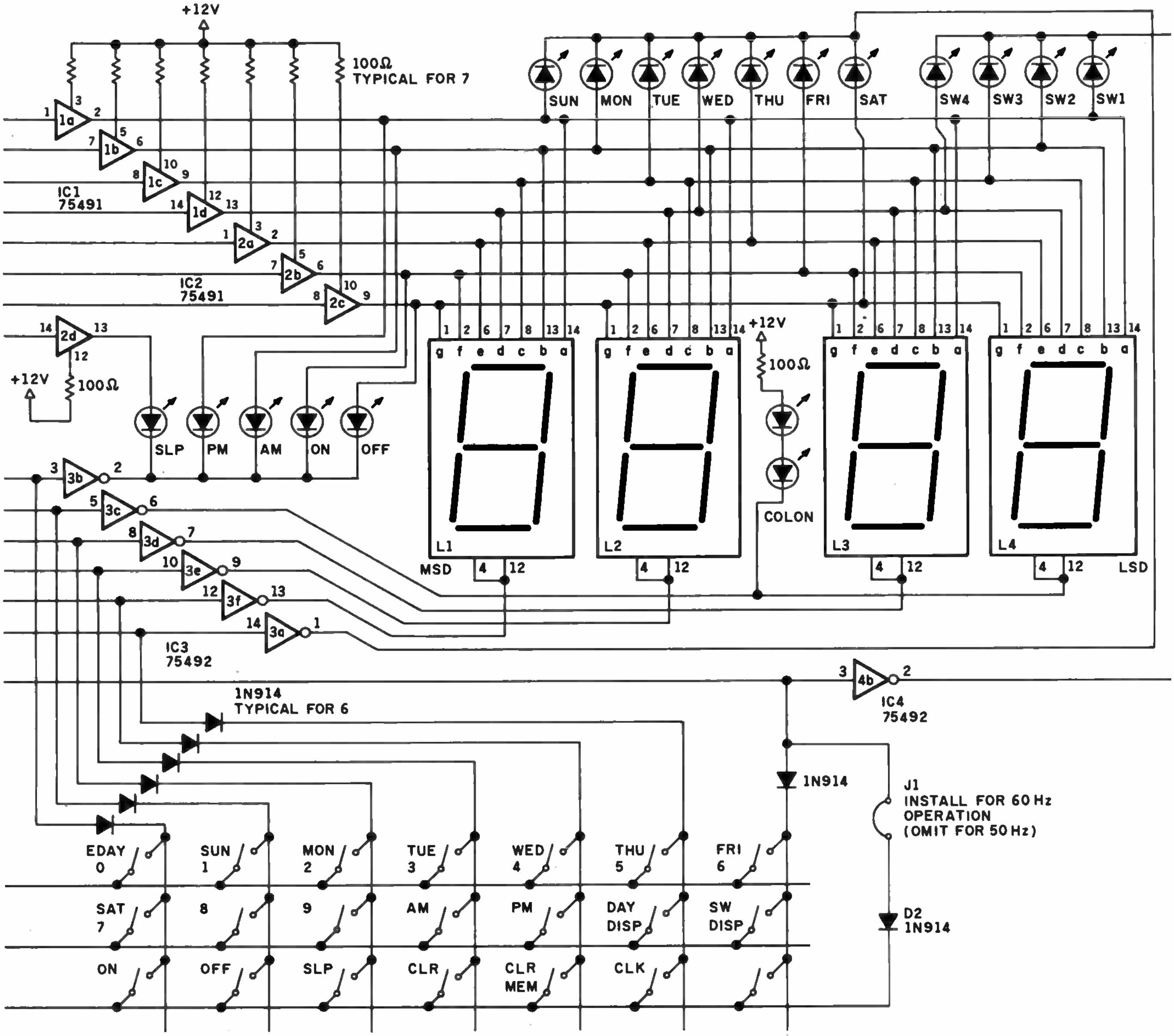
There are two kinds of timer programs: fixed programs and interval programs. Fixed-time programs toggle an output switch at a specific time of day, while interval programs toggle an output switch when a certain interval of time has elapsed since the previous toggling of the switch. Fixed-time programs are retained in memory and repeatedly executed. Interval programs are automatically deleted after execution.

Each program setting toggles only one switch, but a special function exists to combine on/off operations into one program sequence: the SLP (sleep) function is used to turn a switch on and then off 1 hour later. I'll tell you more about programming the RTC-4 later.

RTC-4 Hardware

Figure 2 is a simplified block diagram of the RTC-4, and figure 3 is the schematic diagram. Most of the circuitry of the RTC-4 is associated with the keypad and display and is multiplexed.

As with the other members of the TMS1100 group, the input lines on the TMS1121 are designated K1, K2, K4, and K8 (after their binary significance), and the two sets of output lines are labeled O0 through O7 and R0 through R10. The eight O output lines are configured during the mask-programming of the chip such that only certain combinations of their output values are attainable. Rather than a full range of 256 values, these eight lines can be set only to a



Number	Type	+5V	GND
IC1	75491	11	4
IC2	75491	11	4
IC3	75492	11	4
IC4	75492	11	4
IC5	TMS1121C	20	4

specific subset of combinations defined by the accumulator and status flags. Most frequently the O lines are used as display drivers or status indicators. In this application, very few combinations of the eight O lines are necessary. The 11 R-series output lines, on the other hand, are treated separately; each R line can be set or cleared individually.

The O0 through O7 lines are data-output lines used here to convey the mode, day, switch, and seven-segment codes (for the display) along a time-multiplexed bus. Each O line is buffered through a type-75491 MOS-to-LED-segment driver. Line O0 is segment A, O1 is segment B, and so on through O6, which is segment G. Line O7 is called the decimal-point segment even though no decimal points are used in this application; O7 is attached to the LED that indicates operation of the SLP (sleep) command.

Output lines R0 through R6 are the digit-select lines. Each of the four numeric digits in the LED display module is composed of a cluster of seven segments; the O lines control the segments, while each of four of the R lines activates a digit cluster. Each of the digit-select lines is buffered through a type-75492 signal-inverting MOS-to-LED digit driver. Only one digit-select line is active and one display group illuminated at a time, but by sequencing (multiplexing) through all the digits rapidly, the system can make all the LEDs appear to be illuminated simultaneously.

The two MOS-to-LED drivers, the 75491 and 75492, are designed to

R0 — Mode	— AM, PM, ON, OFF, SLP
R1 — Tens of hours	— 0, 1, or 9 (error)
R2 — Hours	— 0 through 9
R3 — Tens of minutes	— 0 through 5 and 9 (error)
R4 — Minutes	— 0 through 9 and colon
R5 — Day of week	— SUN, MON, TUE, WED, THU, FRI, SAT
R6 — Switch	— SW1, SW2, SW3, SW4

Table 2: *Groups of LED status and numeric displays in the RTC-4, along with their corresponding select lines.*

drive common-cathode LED displays. The 4-digit numeric module is wired for common-cathode operation, and I set up the discrete LEDs in the three other display groups as common-cathode also. By impressing a logic high level (binary 1) on the O lines and logic low level (0) on one of the digit-select lines, the LEDs of each of the display groups can be lit. The seven display groups and their individual select lines are shown in table 2.

In addition to functioning as digit-select lines, the R0 through R6 outputs are used in combination with the K-group input lines in scanning the keypad matrix for user input. As each display group or digit cluster is selected in its turn by an R line, the same R line applies a logic 1 to a column of three keys (or two keys on the R6 line). If one of these three keys is pressed during the application of this scanning signal (thereby closing the circuit), the signal will flow into one of the three K input lines. The program in ROM determines which key has been pressed by reading the K lines in sequence and comparing the combined R and K addresses. This procedure includes use of a 10-ms (millisecond) software contact-debouncing subroutine.

The remaining four R output lines (R7 through R10) are the timer outputs. Buffered through some more sections of a 75492, these signals, in the case of the RTC-4, drive electromechanical relays; you could use solid-state relays also to control external equipment.

The rest of the RTC-4 consists of the power supply and timing sections.

The TMS1121 uses a resistor and a capacitor in a tuned circuit, rather than a crystal, to set its internal clock frequency. This is adequate because the real-time-clock function is synchronized to the 60- or 50-Hz AC power line, and the actual processor clock speed is not critical.

With the 47-picofarad/47k-ohm resistor/capacitor combination shown in the schematic, the clock frequency should be about 300 kHz. The 60- or 50-Hz timing signal is derived from one side of the power-supply transformer. This clock signal is made more square by the transistor Q1 and applied to the K8 input line. If the frequency source is 60 Hz, then you should install jumper J1 (it is omitted for 50-Hz operation). The INIT input pin, connected to diode D1 and capacitor C1, functions as a power-on reset line.

The RTC-4 keyboard has 10 dual-function and 10 single-function keys; programming is relatively straightforward.

The power supply requires a center-tapped (CT) step-down transformer that has an output between 20 and 24 V (volts). I used a 300-mA (milliampere), 22-V CT unit (Micromint PITB-109), but a 450-mA, 24-V center-tapped transformer from Radio Shack (catalog number 273-1366) should also work. The RTC-4 cannot be battery powered because the power line's frequency is used for timing. The rest of the power-supply circuit consists of a standard type-7805 three-terminal voltage regulator configured for a +9-V output with a zener diode to raise its ground reference potential.

If you don't have any 4- or 5-V zener diodes for this kind of circuit, I recommend that you use an LM317 regulator instead. The power for the displays and relays need not be well filtered or regulated; it can be derived directly from the rectifier output when using a 22-V transformer. In the case of higher-voltage transformers, you might need to add a 7812 regulator to keep the LED drivers from dissipating too much power.

Keypad Programming

Programming the RTC-4 is relatively straightforward. The keyboard has 10 dual-function and 10 single-function keys, as shown in table 3.

When the RTC-4 is turned on, the display will automatically read Sunday at 12:00 p.m. if the unit is configured for 60-Hz operation (with jumper J1 installed). If the RTC-4 is set for 50 Hz, then you must press the CLK key to start it. Obviously, after you turn it on in this fashion, the first thing to do is set the correct time on the clock.

For instance, entering the following keypress commands:

SUN, DAY, 1, 1, 2, 4, PM, CLK

sets the clock to 11:24 p.m. Sunday evening.

The pattern for setting the clock is always the same. The day of the week is registered by typing, in this case, the SUN and DAY keys. The SUN key could be interpreted as meaning "1", but the entry of the DAY key immediately afterward leaves no ambiguity, and the software can determine your intent. (Texas Instruments uses the name WEEK for this key, instead of DAY, but since all entries involve a day setting, I felt that DAY was better than WEEK as the key legend.)

After the day of the week has been set, you tell the computer the hour and minutes, and whether these are antemeridian or postmeridian (a.m. or p.m.). Once the proper day and time have been selected, you press the CLK key to start the real-time clock from that setting.

Direct Switch Control

The RTC-4 controls external devices and appliances through four relay-switch outputs designated SW1, SW2, SW3, and SW4. These switches can be individually turned on or off at specific times under program control, or they may be directly controlled from the keypad. To directly turn switch 2 on and then off, the commands would be:

2, SW, ON, . . . 2, SW, OFF

An alternative to separate on/off command sequences is the SLP (sleep) command. The sequence:

2, SW, SLP

will turn switch 2 on immediately and then automatically off 1 hour later. Any of the three basic functions, SLP, ON, or OFF, may be specified for any of the four switches. But the direct control sequences are not stored in RAM.

Fixed-Time Programs

Fixed-time programs change the state of the switch when the clock reaches a preset time. A typical sequence for entering a fixed-time program would be:

3, SW, MON, DAY, 9, 0, 0, AM, ON

This series would turn on switch 3 on Monday morning at 9:00 a.m. The first two keys, 3 and SW, indicate a switching function for the specific output channel 3. Next, you enter the day and time in the same manner as if you were setting the clock. Finally, you designate the action desired, ON.

As the key sequence is entered, the digital readout and LED indicators display the program settings. The day, time, and program function are automatically stored but will continue to be displayed until another sequence is initiated. To return the display to the current-time digital-clock mode, press CLK.

If the switch being controlled or day of the week differs in the next sequence from the preceding setting, the preceding key sequence must be repeated in its entirety with the new parameters. If, however, the switch number and day of the week are the same, a shortened sequence can be used:

1, 1, 4, 5, AM, OFF

If both of the above sequences are entered, the combined result would be to activate switch 3 on Monday at 9:00 a.m. and deactivate it at 11:45 a.m. the same day. In the case of my tape recorder, I want the action to take place every day, so I use the EDAY (every day) command to turn the recorder on every day at 5:30 p.m. and off at 7:00 p.m. as follows:

1, SW, EDAY, DAY, 5, 3, 0, PM, ON

7, 0, 0, PM, OFF

Exceptions to this can be added as separate program lines. Because the radio program I record runs for only 30 minutes on weekends, instead of the usual 90 minutes during the week, I can shut the recorder off 60 minutes sooner on Saturday and Sunday:

You are able to display stored timer settings by the day or by the switch channel. Status LEDs show pertinent information.

1, SW, SAT, DAY, 6, 0, 0, PM, OFF

1, SW, SUN, DAY, 6, 0, 0, PM, OFF

Interval Programs

In an interval program, the function is performed after the specified time interval has passed. For example, in the sequence

4, SW, 2, 3, 0, ON

switch 4 would be turned on 2½ hours after the last key in the sequence is pressed. ON, OFF, and SLP commands can be used in interval programs. If SLP were substituted for ON in the above entry, switch 4 would have been turned on after 2½ hours and off again after 3½ hours from the time of programming. The maximum time length for any interval is 11 hours and 59 minutes. Interval programs can also be combined in the same manner as the fixed-time programs:

4, SW, 3, 0, ON

3, 1, OFF

These commands cause switch 4 to be activated after 30 minutes and deactivated after 31 minutes. The result is a 1-minute "on" time that starts 30 minutes after command entry.

Double-Function Keys	
EDAY/0	- Everyday or 0
SUN/1	- Sunday or 1
MON/2	- Monday or 2
TUE/3	- Tuesday or 3
WED/4	- Wednesday or 4
THU/5	- Thursday or 5
FRI/6	- Friday or 6
SAT/7	- Saturday or 7
SW/DISP	- Switch or Display switch-program memory
DAY/DISP	- Day or Display daily-program memory
Single-Function Keys	
8	- Numeric 8
9	- Numeric 9
AM	- AM time setting
PM	- PM time setting
ON	- Switch on
OFF	- Switch off
SLP	- Sleep — switch output on for 1 hour then off
CLR	- Clear entry or Error
MEM CLR	- Clear Program Memory
CLK	- Set or display clock

Table 3: *Functions of keys on the RTC-4's keypad; some have two functions, others only one.*

Program Display and Errors

Stored timer settings can be displayed by the day or the switch channel. For example:

2, SW, SW, . . . SW, SW

would display all programs affecting switch 2. As each step is displayed, the status LEDs and numeric display show pertinent information such as the time, day, and what relays are set on or off. Entering

SAT, DAY, DAY, . . . DAY, DAY

Prototype Construction Techniques

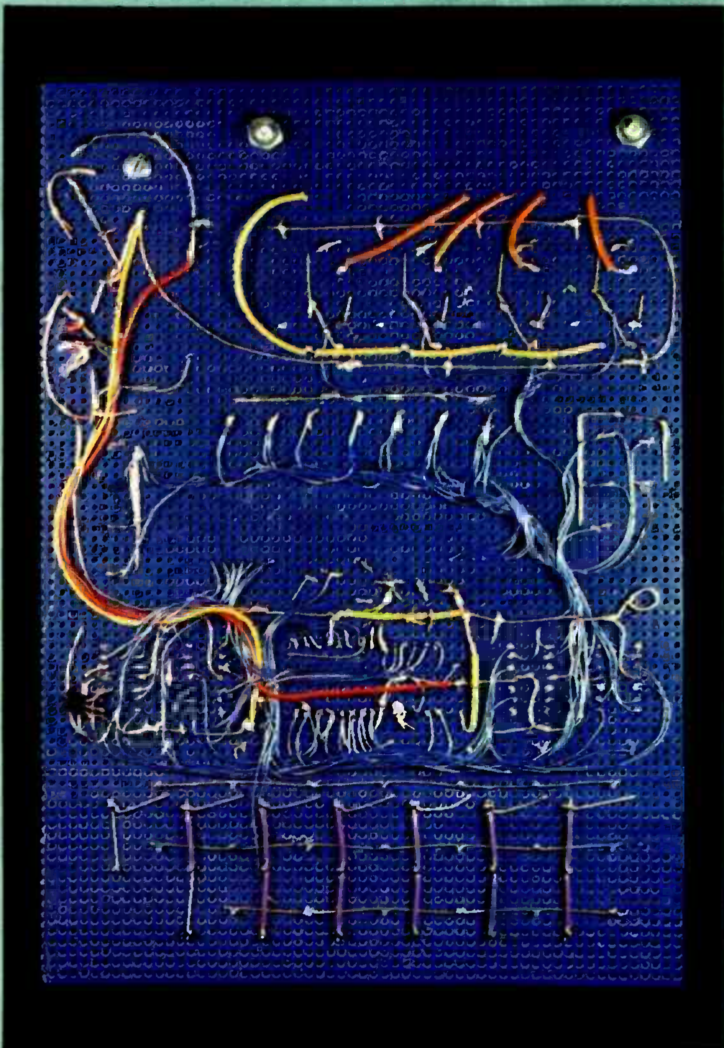


Photo 2: *Back side of the RTC-4 prototype.*

I receive at least half a dozen letters each month asking me how I put my project prototypes together and wire them. This month I'll reveal a few of the techniques I exercised in building the RTC-4.

To begin with, I don't recommend my techniques for everyone. I try to keep the circuit boards very small and lay the components out in an aesthetically pleasing arrangement. The results are not particularly easy to troubleshoot or modify.

I use standard integrated-circuit (IC) sockets (I prefer the Amp brand), and I hard-wire the power-supply and ground bus lines around the perforated project board using 22-gauge tinned bus wire. These soldered power connections fasten the IC sockets to the board.

Next, I insert the discrete components into the board and if possible directly route their leads to the appropriate pins on the IC sockets. When I absolutely must cross some leads, I use Teflon-insulated wire or sleeving. I finish by using 28- or 32-gauge wire-wrap wire to finish the connections, but I point-to-point solder them.

This may seem tedious, but I end up with a low-profile package, shown in photo 2, that looks very much like a commercially produced unit. It took me about 14 hours to assemble the RTC-4 prototype. Some of my other projects take much longer.

One detour I traveled during the RTC-4 project was the result of wanting large LED-display digits. I had some 0.3-inch type-MAN74A common-cathode single-digit display components, but I decided to adapt a 4-digit 0.7-inch display component I found in my junk box. Unfortunately, units of that type are not intended to be driven as multiplexed displays, and the digits are not wired individually. I had to disassemble and rewire it so that it functioned as 4 separate digits. Photos 3a through 3d show the process. It was so much trouble that I would just use the MAN74As if I were doing it over.

instead displays the programs for a particular day. You can also display those for every day (use EDAY).

Errors in command entry are indicated by the appearance of all nines ("99:99") in the display, which can be cleared by the entry-clear key, CLR, or the program-memory-clear key, MEM CLR. It is possible to selectively clear program segments. For example, entering

1, SW, MEM CLR

would erase all programs pertaining to switch 1. Similarly, entering

FRI, DAY, MEM CLR

erases any Friday programs.

Applications

Obviously, one of the more practical uses for the RTC-4 is to enhance your home's security by giving your house that lived-in look. If, for example, you have three lights and a stereo system plugged into the RTC-4, you could go away for weeks at a time and leave everything blinking on and off and sounding away. Because the RTC-4 can be programmed for sequences of one week, most normal home activities can be simulated. It is certainly more cost-effective and reliable than other timer-controllers I've seen.

A Previous Project's Woes

Some of you might have wondered why I didn't use the BSR X-10 Home Control System timer unit, which performs many of the same functions. Besides the obvious damper of losing a chance to experiment with some interesting components from TI, eliminating a good article topic, I've had less than consistent results with the X-10 devices over the years.

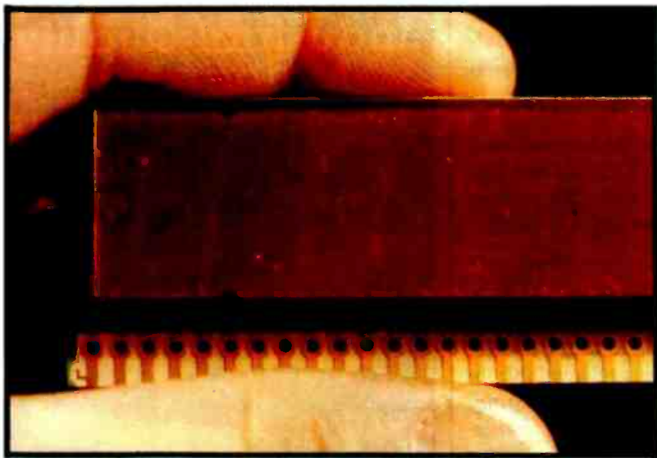


Photo 3a: *This typical National Semiconductor 4-digit LED display (which I believe to be one of the NSB7400 series) is most frequently used in digital clocks. It consists of three parts: a plastic circuit board with LEDs bonded to the circuit traces, a plastic reflective digit form, and a red lens cover.*

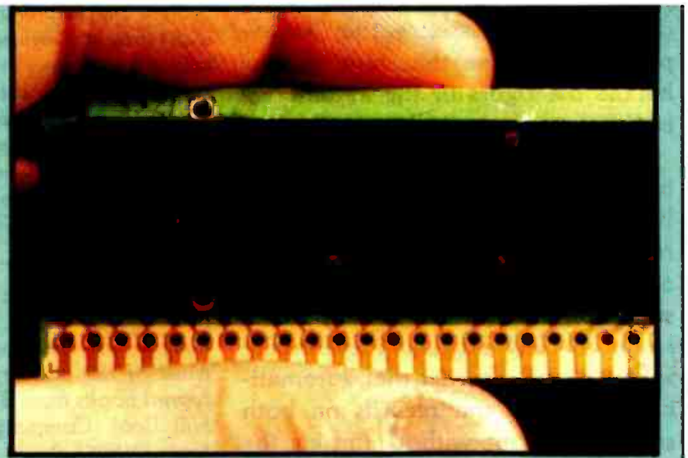


Photo 3b: *The LED display with the lens cover removed.*

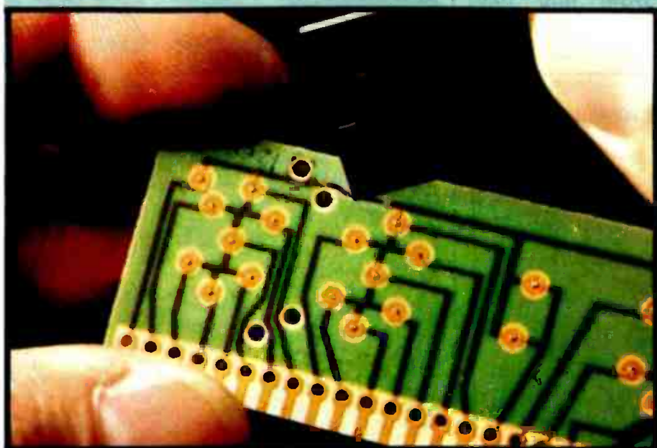


Photo 3c: *Because this display has one common cathode line for all 4 digits, I had to cut it at strategic points to isolate the digits.*

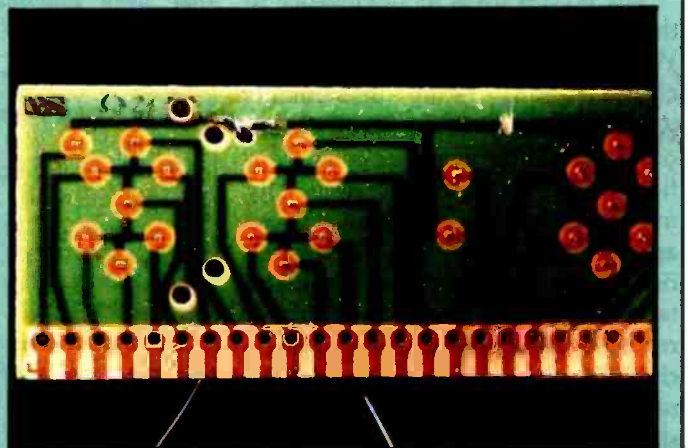


Photo 3d: *Finally, I drilled holes and soldered wires to the individual digit connections.*

At one time (shortly after my article on attaching an X-10 controller to a computer; see reference 1), most of my house was X-10-activated and remotely controlled. Frequently, however, I would find that the switches would reset or change state arbitrarily. I attributed this to power-line transients or electrical noise. Eventually I remedied this situation by retransmitting the intended status of each channel once every minute (obviously a tedious task suitable only for a computer).

Finally, I had a complete falling out with the BSR X-10 system shortly after a thunderstorm a few summers ago. While nothing else (computers, television sets, printers, etc.) in the house was affected, eleven X-10 remote receivers were blown out all at once. I expected to lose a couple receivers now and then, but I didn't expect to replace all of them. And I learned that when a light bulb burned out on a lamp connected to a lamp module, the module was often destroyed. In later production, BSR supposedly installed heavier SCRs (silicon-controlled rectifiers), but this has not completely eliminated the problem. Consequently, I've switched back to the old reliable copper wire and heavy-duty relays. But if I find any better methods I'll be sure to let you know.

A Trick Up My Sleeve

Some of you who are audiophiles might have been wondering how I have managed to record a 90-minute radio program unattended, due to a well-known property of ordinary Philips-type tape cassettes. Strictly speaking, a 90-minute program should just fit on a C-90 cassette. But, of course, a C-90 cassette can record only 45 minutes on one side; people are accustomed to turning the tape over halfway through. (While there do exist C-180 cassettes, they are expensive, and the thin tape doesn't handle the rigors of the automotive environment very well.)

But luckily, when I was still recording manually, I solved this problem. It was hard enough for me to turn the recorder on at all, let alone be there at 6:15 to turn the tape over, so after searching through most of the stereo shops in New England I eventually found a tape recorder that automatically reverses and records on both sides of the tape without turning the cassette over (a Pioneer CTF-750). Now, everything is automatic. But perhaps I should have taken this as an opportunity to build a robot.

In Conclusion

The RTC-4 owes its intelligence to the TMS1121C microcomputer chip. While I used it only in its off-the-shelf configuration, Texas Instruments would like you to know that there are other packaging and functional configurations that can be specifically mask-programmed for high-volume applications. For myself, I'll be satisfied with my somewhat-automatic tape recorder. Of course, to regularly record from radio broadcasts, I had a chat with the program director of the radio station, who gave me permission to record this particular news program. As an author, I'm very careful about copyright infringement.

Next Month:

Use the hidden resource of your electrical power wiring for data communication, using a power-line modem. ■

Acknowledgments

Special thanks to Jeff Bachiochi for his help on this project.

Diagrams pertaining to the TMS1000-series devices are reprinted here through the courtesy of Texas Instruments Inc.

References

1. Ciarcia, Steve. "Computerize a Home." January 1980 BYTE, page 28. Reprinted in *Ciarcia's Circuit Cellar, Volume II*, page 137.
2. Staehlin, David C. "An 8080-Based Remote Appliance Controller." January 1982 BYTE, page 239.

About the Author

Steve Ciarcia (pronounced "see ARE see uh") 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 magazine, he has published several books, including Build Your Own Z80 Computer *(BYTE Books, 1981). His mailing address is POB 582, Glastonbury, CT 06033.*

Editor's Note: *Steve often refers to previous Circuit Cellar articles as reference material for each month's current article. Most of the past articles are available in reprint books from BYTE Books, McGraw-Hill Book Company, POB 400, Hightstown, NJ 08520.*

Ciarcia's Circuit Cellar, Volume I *contains the articles that appeared in BYTE from September 1977 through November 1978.* Ciarcia's Circuit Cellar, Volume II *contains the articles from December 1978 through June 1980.* Ciarcia's Circuit Cellar, Volume III *contains the articles that were published from July 1980 through December 1981.*

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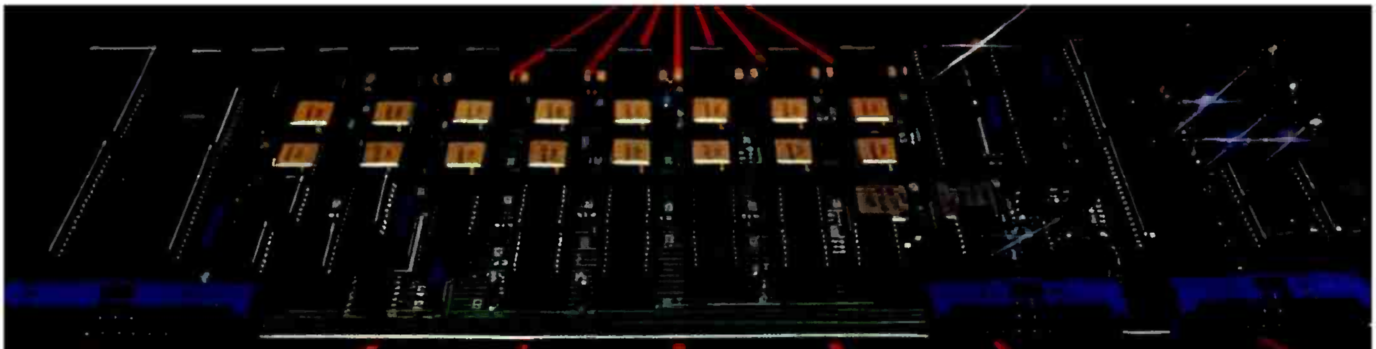

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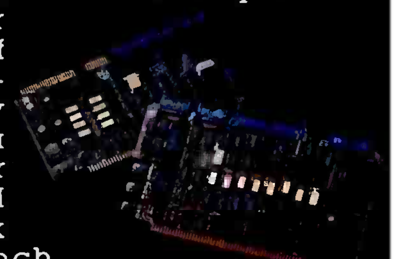

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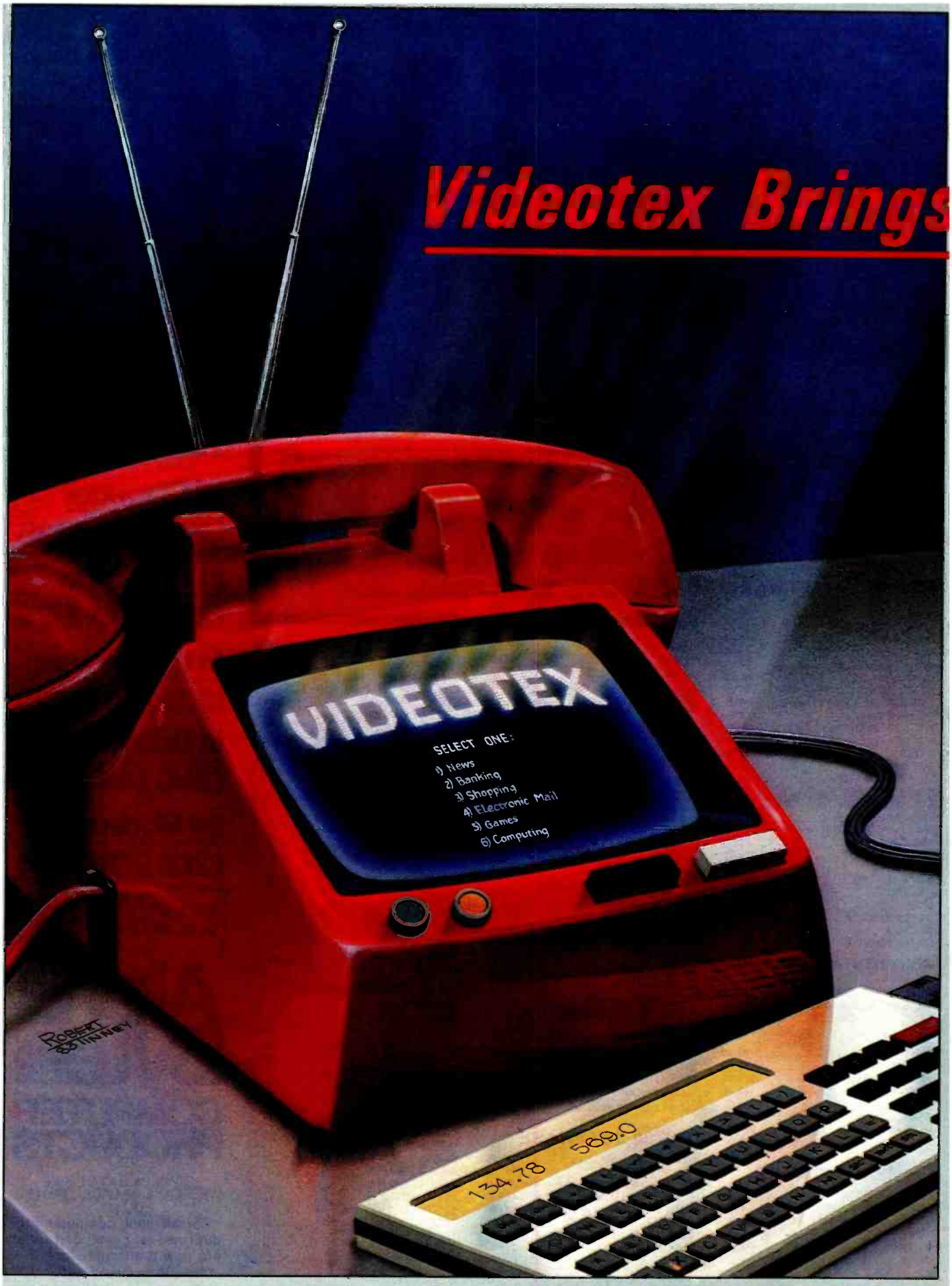
Videotex Brings



the World to Your Doorstep

Take a regular telephone, add a color television set and a small microcomputer, connect them and add some user-friendly software, and what you end up with is a close facsimile of a videotex terminal. Hook this terminal to a large host computer storing hundreds of frames of information and you have something very similar to a videotex system. With such a setup you can, among other things, access a wide range of information, make banking transactions, shop, send electronic greeting cards, and do computations, all in the comfort of your home or office.

Videotex is not an entirely new technology but rather an enhancement of existing technologies, which in certain applications have been found to be inadequate. For example, television is an excellent way to transfer information, but it's unidirectional. The telephone is excellent for two-way communication but it can't accommodate graphics. And personal computers are excellent for processing and transmitting data, but they too are unable to transmit graphic information easily and are sometimes difficult to use. Videotex, a low-cost, easy-to-use, graphics information medium, is designed to serve a market that these other technologies cannot.

But there have been a few problems with videotex. In order for the service to be economical it must have a mass market. But before it can have a mass market it must be economical. This is the familiar chicken-and-egg dilemma: which must come first?

Also, before videotex can become a mass-market item, it must have a standard way of encoding graphic information. Currently about six different videotex protocols are in use worldwide. Each has strong merits. Which one should be adopted?

And what about personal computers? They tend to have good graphics and communications capabilities, although the various graphics systems do not follow any one standard. Will the hundreds of thousands of personal computer owners be required to purchase another machine to take advantage of videotex? Or can they use the system they already own and are familiar with? And how will this new technology affect the design of future personal computers?

Videotex poses some nontechnological problems as well. If videotex becomes a prominent medium, personal information will be circulating in a form that is easily accessible by organizations that are unlikely to have our best interests at heart. For example, a purchase made from a videotex catalog could be monitored by a number of different parties. What rights to privacy do we have when we correspond electronically?

In another context, because videotex is a graphics medium, it will attract artists eager to explore its capabilities for expression. Videotex may offer these artists the opportunity to make their artwork interactive, allowing it to evolve in conjunction with the preferences of the viewer. What will this new art be like?

The purpose of our theme articles is to address these and other questions. We have an overview of videotex describing the various technologies and protocols. We present an article each on two of the more popular protocols, Prestel and the North American Presentation Level Protocol Syntax (NAPLPS). We have an article on privacy, and another that examines how artists are using videotex as a medium. And we offer a commentary on how videotex and personal computers may affect each other.

Someday, according to various videotex proponents, magazine articles such as these in BYTE will appear on your home television screen. Until then, we invite you to curl up with this rather weighty collection of wood pulp and printing ink and enjoy. As big as BYTE is, it's still a lot easier to carry around than a TV. . . . by Rich Malloy

Videotex

Science Fiction or Reality?

by Darby Miller

It's 8:00 A.M., Monday, July 15, 1993. For Tom Benson, it's the start of another work week.

Waking up is still the hard part, but after that things get easier. Tom has coffee, prepared while he slept by a coffee maker controlled by his personal computer. Later he sits down at his computer and simply pushes one of its keys to download the electronic mail sent to him from various other computers during the night.

He reads through the mail and answers those messages requiring immediate responses. One includes a roughly drawn picture of a person on skis, speeding down a slope. Beside it are the words, "Will you make the ski weekend? Signed Carol." Response: "You bet."

Tom remembers he has to get some new skis for the weekend. He calls up a service offering ski equipment, picks out his skis, states size, model, and color and confirms the charge request. A drawing of the skis even appears on the computer screen. The computer tells him he can pick up the skis at the store or they will be sent to him by the next week. He gives instructions to have them sent.

Tom looks through more important mail. A friend George asks, "Should I sell such and such stock today at 452?" This requires a response, but Tom doesn't have the latest information on the stock. He logs on to his stock service, where he finds that that company may soon announce yet another update of one of its incredibly successful products, a move that should prove quite profitable. Under his instructions the electronic service automatically searches out all articles and information that may affect certain stocks. He leaves a message for George not to sell.

Tom then switches to a newsletter service that provides instant coverage of events in his industry. Tom works in telecommunications, and at one time he had to read through several trade journals each day before he went to the office. Now his newsletter service can give him a brief review of each article, or if he wants more than the encapsulated information, he can tell his computer to display the entire article on the screen or print it out. Later, at the office. Tom logs on to another personal computer. Much of the paperwork that he previously had to deal with is gone now, and Tom has more time to think and plan, and more tools to help him make faster, more informed decisions.

INVERTED TREE STRUCTURE

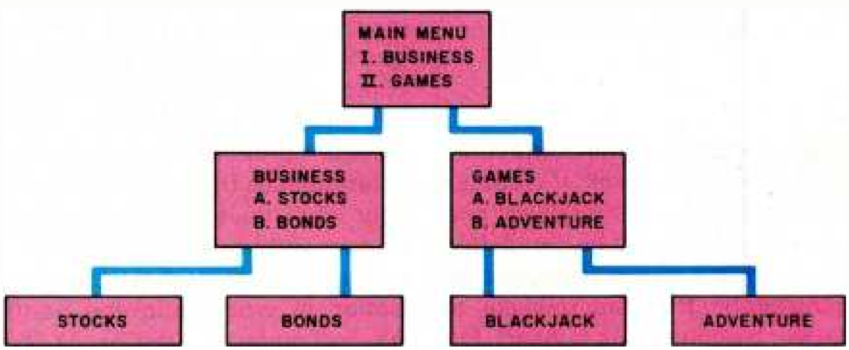


Figure 1: *A simplistic representation of an inverted tree structure. This is a common method for providing easy access to a wide range of data pages. You proceed through a series of menus until you reach the desired page of information.*

From Prediction to Reality

In 1993, people such as our fictitious Tom Benson will most likely continue to use the telephone and read magazines and newspapers, but much of their work and recreation may be planned and accomplished through the use of videotex, a generic term for computer services that display textual and graphical information on remote video screens.

Before we see this ideal picture, however, a great many hurdles must be cleared. The technology is already here; the marketplace, however, is not. Videotex, by the definition of those working in the field, should be a low-cost, easy-to-use system. At this time, it is neither. I'll now give an overall view of the industry as it is developing around the world, showing the types of systems available, the standards, and the tests that have been conducted or are planned for 1983. After reading the facts, perhaps you'll be able to predict the future for yourself.

How It Works

On a videotex system, you select the information you want with the help of a numeric keypad resembling a channel selector or by using a keyboard. You make choices from tables of contents (or menus) and retrieve screens of information (or pages) either by searching for keywords or by following an *inverted tree structure*. You can use keywords to quickly display one or more pages that include that word. Inverted tree structures involve a series of menus, in which each menu choice leads to another menu. You move from general menus to more specific ones until you reach the desired page. (See figure 1.)

In the typical videotex setup, you would have a terminal that connects to a central host computer through a modem, which converts analog signals coming through the telephone lines to digital signals that can be read by the videotex terminal. Another way to receive videotex services is through a cable television network.

A decoder box that sends and receives videotex signals can be built into an ordinary television set during manufacture or added on outside the television set and connected to the antenna terminals.

There are actually two forms of graphics-based data communications. One-way systems, in which you only receive information and cannot transmit any, are called *teletext*; and two-way, or interactive, systems are called *viewdata* in Europe and *videotex* elsewhere. Sometimes two-way videotex is referred to as *interactive videotex*, but here we shall refer to it merely as videotex and will avoid using the term in the general sense. (See figure 2.)

Teletext information is usually transmitted over the vertical blanking interval (VBI) of a television signal (the black bar visible when vertical hold isn't working); the data in the VBI can then be translated into textual and graphics information by a teletext decoder. But teletext can also be sent on a subcarrier of an FM or television broadcast signal or even on a whole cable television channel. Current FCC (Federal Communications Commission) regulations prohibit using a whole *broadcast* channel.

Videotex may be carried over telephone lines, cable television, or optical fiber. It can also be transmitted via satellite. In addition, a hybrid system, consisting of a one-way broadcast signal to a teletext receiver

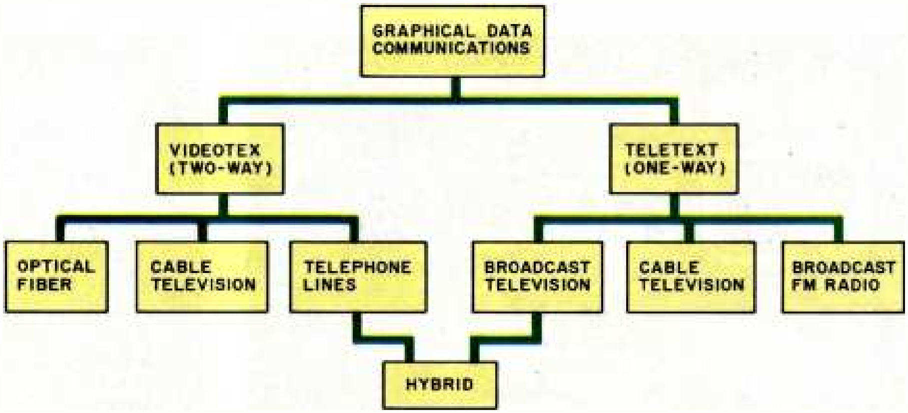


Figure 2: *The different videotex technologies. Videotex and teletext are two different ways of communicating graphics data. The term videotex usually refers to a two-way system where you can interact with the host computer system. In teletext, a one-way system, you merely select which of a limited number of pages you would like to see. Both teletext and videotex can use a variety of transmission methods. In a hybrid system, a teletext decoder can function as an interactive videotex terminal by sending information back to the host computer over phone lines.*

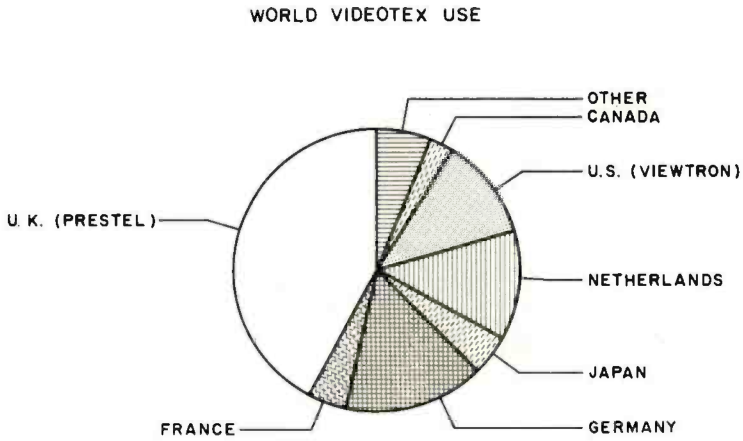


Figure 3: *A pie chart showing approximately how world videotex use is divided between various countries. This does not include use of teletext. The data for the U.S. includes the proposed 5000 users in the Viewtron test in southern Florida. If the subscribers to such videotex-like services as Dow Jones News Retrieval, Compuserve, and The Source were included, the U.S. portion would take up more than half the chart.*

with return communication through the telephone, has also been developed.

Different Protocols

Videotex and teletext were born in the United Kingdom in the early 1970s and have been struggling into adolescence ever since. In 1979, the British Post Office—now British Telecom—began offering videotex (viewdata) as a commercial service.

The British version of videotex is called Prestel. Ceefax and Oracle are the British teletext services, which have proved to be quite popular. In the U.K., 800,000 television sets are now equipped with teletext decoders.

British consumers, however, have not yet fully embraced Prestel. It has only 24,000 paying subscribers, most of whom use the system for business. However, at this time it is still the world's largest videotex service (see figure 3). Information providers (IPs) on the Prestel system include *Barron's*, American Express, and shipping and travel agencies. You can make restaurant and ticket reservations through the system, access business information, order goods, and read various publications [see Graham Hudson's "Prestel: The Basis of an Evolving Videotex System" on page 60].

Although the Prestel service is basically business-oriented, certain consumer publications such as the Hearst Corporation's *Family Living* magazine have Prestel versions that have been successful. *Family Living* presented Harrod's Christmas catalogue in 1982, displaying some of the famed department store's wares and enabling users to make purchases via the service.

The Prestel format for videotex differs from that followed by other, later systems developed in France, Japan, and Canada. It uses *alphamosaic graphics*, pictures composed of small, character-size blocks. The resulting graphics images have fairly low resolution (see photo 1).

The original French format, called Antiope, developed by the French PTT (Post, Telephone, and Telecommunications Ministry) used alphamosaics but also employed *dynamically redefinable character sets* (DRCS) that allow the system to exchange one series of characters for another.

DRCS can also be helpful in defining separate graphics so the French system has a more refined look.

Another difference between the British videotex technology and the other technologies is that the British use *serial coding*, meaning that for every character appearing on the monitor, a corresponding character is

Photo 1: *Four examples of pictures produced on the British Prestel system. (Photos courtesy of Logica/BVT Marketing.)*

sent over the transmission lines. If only one character is incorrectly transmitted, very little information is lost.

The French system, on the other hand, uses a parallel-coding technique with asynchronous transmission. The signal is sent out in bursts rather than in a continuous stream. The French feel this is a more economical use of data-transmission techniques.

The British technology is endorsed by the Conference of European Posts and Telecommunications (CEPT). The German videotex system (Bildschirmtext) grew out of the British system, as did the systems being developed by Belgium, Italy, and The Netherlands. Austria's MUPID (Multipurpose Universally Programmable Intelligent Decoder) and Norway's Teledata also use the CEPT (British) format.

A third system, Telidon, was developed by the Canadian Department of Communications. This technology uses *alphageometrics*, where shapes are not defined by a series of boxes but by geometric elements such as points and lines. The points are connected according to certain commands, called *picture description instructions* (PDIs), such as arc, rectangle, circle, square, polygon, and line. A set of points can be connected by merely specifying a series of points and issuing a draw instruction, such as "arc."

VIDEOTEX PROTOCOLS

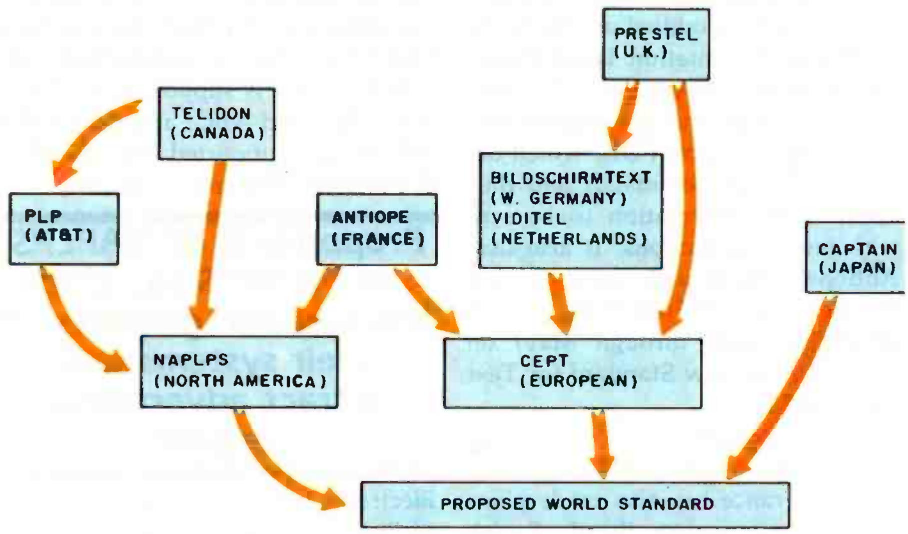


Figure 4: *A genealogical chart of the different videotex protocols. Prestel, the British videotex protocol, was first introduced around 1976. Later systems are either based on Prestel or have added significantly enhanced graphics capabilities. The CEPT (Conference of European Posts and Telephones) standard is based predominantly on Prestel. Although the various protocols are fairly incompatible, they are being merged into a world videotex standard.*

The best feature of Telidon is that it provides a sophisticated graphics environment that appeals to consumers and advertisers, two necessary elements of a mass videotex service. The argument against Telidon is that the equipment needed to receive the high-resolution graphics may be too expensive to gain acceptance in the marketplace.

The Japanese have developed yet another videotex system, called CAPTAIN (Character and Pattern Telephone Access Information Network). This system is *alphaphotographic*; the screens look very much like still photos, and each individual point on the screen is addressed separately. This is necessary to accommodate the great variety of Japanese characters.

Unfortunately, these systems are not compatible with each other at this time (see figure 4).

Two years ago AT&T developed

another videotex system called PLP (Presentation Level Protocol), based on the Telidon technology. This system was later modified as the North American Presentation Level Protocol Syntax (NAPLPS). It uses Telidon's PDIs and alphageometrics and employs macro-PDIs, which define a series of commands and thus allow more information to be sent with fewer instructions. It also uses Antiope's DRCS and Prestel's alphamosaics. [See Jim Fleming's four-part series (February through May) on "NAPLPS: A New Standard for Text and Graphics."]

Canada has decided to upgrade its technology to meet NAPLPS specifications. France has also made plans to upgrade its system. But the British have not agreed to go along with the NAPLPS protocol. A worldwide videotex standard is now being developed.

Videotex and Teletext in America

The U.S. government has not yet approved any standard for videotex or for teletext. It seems that only two standards for teletext are being considered seriously: the North American Broadcast Teletext Specification (NABTS), which is compatible with NAPLPS and is supported by Time Inc., CBS, and NBC; and the British technology supported by Satellite Syndicated Systems and Keycom

Proponents of NAPLPS and NABTS say that the superior graphics of their systems will attract advertising support.

Electronic Publishing (a joint venture of Field Enterprises, Honeywell, and Centel Communications). Taft Broadcasting and Zenith Corporation have announced plans for a teletext system using the British technology to be launched in Cincinnati. Zenith has stated, however, that it will make hardware for any type of system.

NBC and CBS have announced plans for the 1983 launch of two national teletext systems supporting the NABTS format. Times Mirror and Viewtron, a subsidiary of Knight-Ridder, have both announced plans for 1983 launches of videotex systems using the NAPLPS format.

A strong argument for the simpler British teletext format is that it is already in commercial use. The system is presented by its supporters as being affordable for mass-market distribution and relatively error-free in transmission.

The proponents of NAPLPS and NABTS state that their systems will have very good graphics capabilities to interest advertisers who might support various system offerings and that the decoders, when produced in mass quantities, will be comparable in price to British decoders.

At this time, the cost of British television sets equipped with interactive videotex decoders is approximately $200 (U.S.) over the cost of a standard color television set. Add-on decoders that would attach to standard television sets would cost approximately $250 for the British version and approximately $450 for the NAPLPS version if produced in large quantities. American Bell Inc. (an AT&T company) and Norpak (a Canadian company) have produced prototypes of NAPLPS terminals. American Bell will be marketing NAPLPS terminals at a special introductory price of $600 for the Viewtron test in southern Florida this year. Norpak's decoders are approximately $1000, with prices expected to go down to $500 per decoder by the middle of 1984.

Matsushita has just signed an agreement with Time Video Information Services (of Time Inc.) to codevelop hardware for its teletext services. The first products will be teletext terminals selling under the Panasonic name for approximately $150 each.

Personal Computers and Videotex

Although the technology behind videotex is new and barely out of the trial stages, it is merely an extension of traditional online services. Videotex should allow the unsophisticated

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Service	Advertising	Graphics	Startup Date	Coding Technology	Users
CBS/AT&T	yes	yes	1982	PLP(AT&T)	200
Compuserve	yes	no	1980	ASCII	45,000
Dow Jones	no	no	1977	ASCII	60,000
Keyfax (teletext)	yes	yes	1982	Prestel	2500
Viewtron	yes	yes	1980	PLP (AT&T)	200
			1983	NAPLPS	5000
Qube (Warner Amex)	yes	yes	1977	Text & Video	50,000
The Source	yes	no	1979	ASCII	27,000
Time Inc. (teletext)	yes	yes	1983	NAPLPS	400
Times Mirror	yes	yes	1982	NAPLPS	350

Table 1: *Videotex and teletext tests being performed in the United States.*

user access to many kinds of information. This will be similar to the way user-friendly software, which can be used by professionals in all fields, not just computer science or data processing, has helped personal computer growth to become extraordinary.

A large part of the planned videotex audience will include personal computer users. Some personal computers may be adapted to videotex terminals, and dedicated videotex terminals may have a number of computer-like features. Depending on the amount of processing power built into videotex decoders, some may even use interactive game services, and have software downloaded to them.

Videotex is not in competition with personal computers; both are part of a new world of telecommunications. The difference is that personal computer owners can process information on a stand-alone basis, while videotex users may be dependent on processing power resident in a distant mainframe computer. But in many cases, that processing facility, regardless of geographic location, is only a local telephone call away.

Many people see videotex as the gateway to myriad other services. Data processing professionals have seen this type of computer interaction for some time in the form of distributed processing.

Videotex terminals may be hooked up to television sets just as personal computers and game machines are. The terminals may communicate with personal computers and vice versa. Therefore, the issue is not whether videotex will overtake personal computers, but rather whether the combination of the consumer and business markets for videotex services will be enhanced by the growth of the personal computer market. Each one should generate interest in the other.

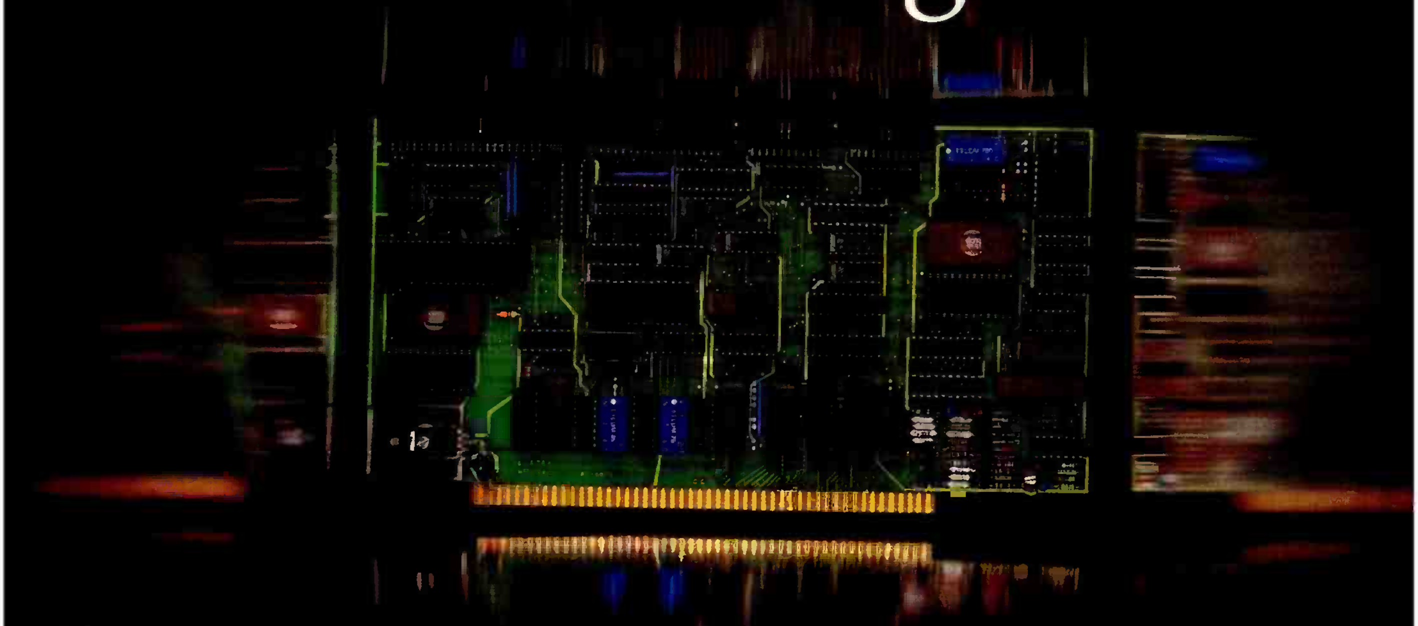
What new users can expect to find are specialized services similar to those now available from the Dow Jones Information Service, which appeals to businessmen interested in financial news. Dow Jones' subscribers now number 60,000. The service, begun in 1977, offers a Media General database, the *Academic American Encyclopedia*, *The Wall Street Journal* Online, *Barron's*, and more. Dow Jones recently developed software for the service that enables subscribers to chart performance of stocks and update and evaluate portfolios using the News Retrieval Service. Software development is going hand in hand with videotex-like service development, with the idea that personalized usability of interactive services will make for long-term subscribers.

Videotex and Teletext Tests

Although there is little real videotex and teletext usage in the U.S., a number of tests are being performed, and videotex-like services such as Dow Jones have been quite popular (see table 1).

On October 31, 1982, the Time Video Information Services division of Time Inc. began its teletext test in San Diego, California, and Clearwater, Florida, in partnership with

Bored Waiting? Here's The Board You've Been Waiting For.



A hard disk and cartridge tape controller together on one board? Magic? Not really. It's Teletek's HD/CTC. The hard disk and cartridge tape drive controller provide the support necessary to interface both rigid-disk drives and a cartridge tape deck to the S-100 bus.

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- Controller communications with the host processor via 2K FIFO at any speed desirable (limited only by RAM access time) for a data block transfer. Thus the controller does not constrain the host processor in any manner.
- Two 28-pin sockets allowing the use of up to 16K bytes of on-board EPROM and up to 8K bytes of on-board RAM.
- Individual software reset capability.
- Conforms to the proposed IEEE-696 S-100 standard.
- Controller can accommodate two rigid-disk drives and one cartridge tape drive. Expansion is made possible with an external card.

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Photo 2: *Examples of pictures created on Time Video Information Services' teletext system. This system uses a protocol based on NAPLPS and thus is capable of fairly high resolution graphics.*

the Copley Press and *The Orlando Sentinel*. They are offering 4000 to 5000 pages of information on entertainment, national and local news and weather, travel, stocks, and education (see photo 2).

Time will offer a national teletext service in late 1983 to be aimed at a wide consumer audience. Time will use a full cable channel to deliver the one-way service with advertiser support. Users may select pages of information from a continually changing cycle of pages. Because Time is not limited to using the vertical blanking interval (VBI), it can put out 5000 pages of information, whereas most VBI services put out only 200 pages. Time is also offering an interactive game feature, household hints, sports scores, news, weather, and restaurant guides.

Chemical Bank, Chase Manhattan, and Citibank in New York City are all experimenting with banking services using interactive videotex.

Using a videotex service, electronic banking might be linked to shopping by computer, with credit checks and billing handled automatically.

These systems, however, are not graphics-oriented. Chemical intends to license its system, called Pronto, to other banks. Because paper-based banking is becoming more and more expensive, banks are looking for ways to cut down on the expense of processing checks and to speed up the collection of money. Electronic banking might be the solution, but some banks feel that a banking service alone will not be enough to entice banking customers to buy videotex terminals.

Again, the idea of distributed processing or videotex "gateway" connections between geographically disparate computers becomes more appealing. If bank customers could also order merchandise, for example, with merchants having immediate credit checks performed and automatically generated billing, both the banker and the retailer might profit from operating or supplying information to a videotex service.

The questions are Does the consumer want the information in electronic form? and Will the price be acceptable? Studies have shown that

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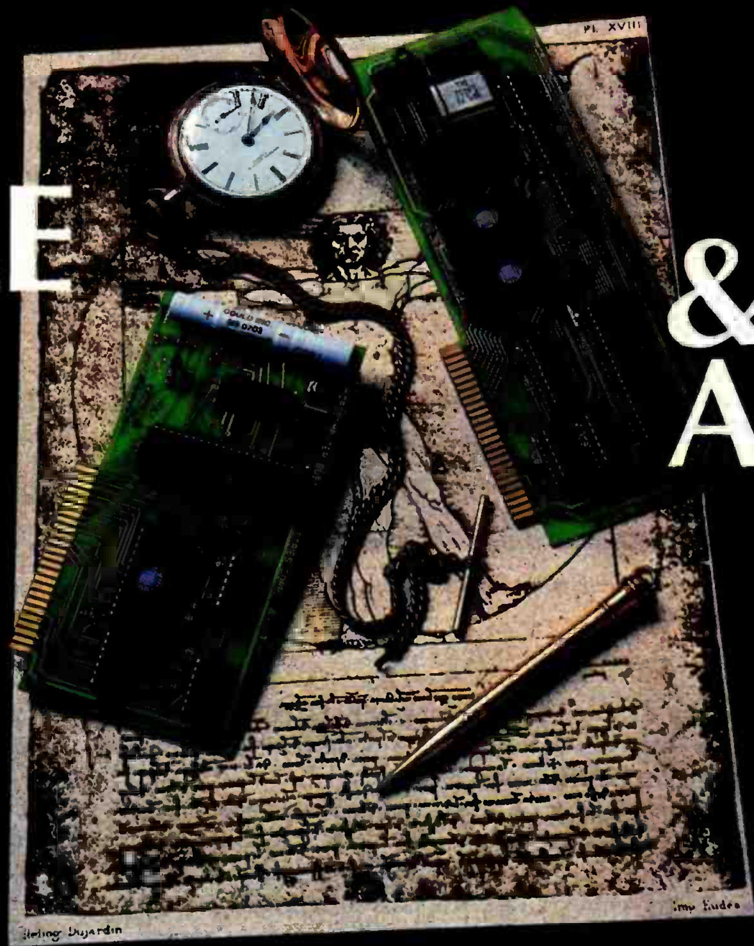

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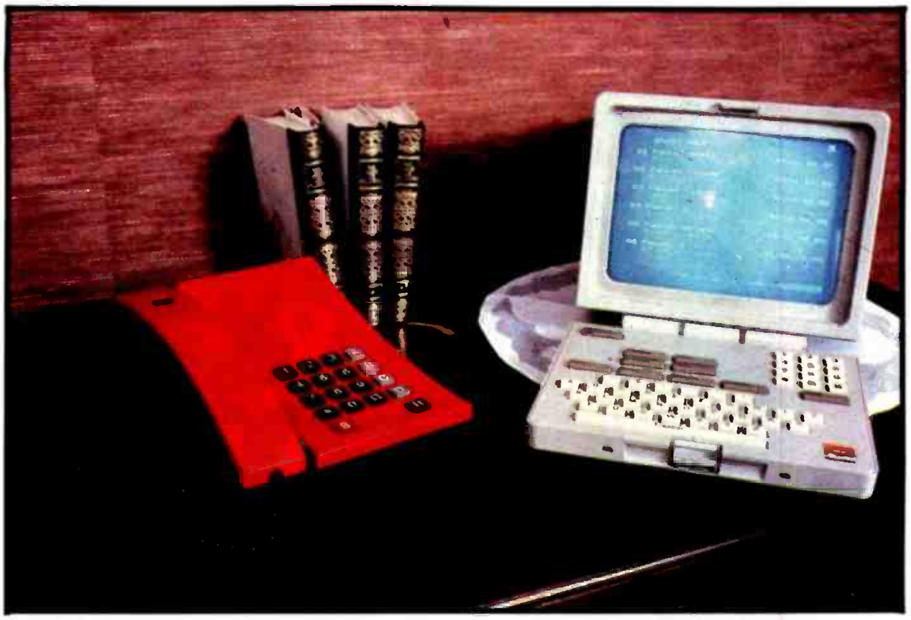

Photo 3: *A terminal that is used in the French Teletel system for electronic access to phone directories and other services.*

users may have to pay from $15 to $40 per month for videotex services.

The teletext service Keycom, first offered by Field Enterprises Inc. over broadcast station WFLD in Chicago, is now transmitted on the VBI of the WTBS Satellite Service. Keycom offers weather, sports, and leisure information 24 hours a day. The National Keyfax magazine is a joint venture between Satellite Syndicated Systems (SSS) and Keycom.

Ongoing U.S. videotex tests include a CBS/AT&T test in Ridgewood, New Jersey, Cox Cable's Indax in San Diego, and various agricultural services.

The Warner Amex Qube system in Columbus, Ohio, begun in 1977, is going strong with 50,000 subscribers who receive videotex-like services over cable.

Canada has many experiments operating, including Grass Roots in Manitoba and Teleguide in Ontario. Grass Roots is an agricultural database that Canadian farmers are using to check weather, grain futures, and livestock prices. Teleguide is a kind of electronic Michelin Guide offered in public places to let city visitors know what's available—from museums to nightclubs—and how to get around town.

The French have completed two videotex tests, including an electronic telephone directory project with 1400 users and a total service, known as 3-V (for Velizy, Versailles, and Val de Bievre), with 2500 subscribers.

France is putting millions of dollars into a countrywide electronic yellow-pages project that is expected to serve all of France by 1986 and save even more millions in the cost of producing and updating print directories. Along with the yellow pages, other features are being offered. The electronic directory trial uses stand-alone terminals (photo 3) capable of linking into Teletel, the French videotex service.

The 3-V trial included transactional services where users had "smart cards" containing a microprocessor capable of storing an individual's one-year credit or complete medical history. The cards were put into card readers near the terminal and credit checks could be performed on the spot.

French studies show that games and entertainment sections such as horoscopes were used more widely than any other interactive videotex feature when the services were first introduced. Another very popular service was electronic mail. Most information providers in France have begun to use video games to draw users to their databases, even though the games may have very little to do with the other information offered.

The French technology is being used in a test with 200 farmers in Fargo, North Dakota, sponsored by First Bank System. J. C. Penney (which recently purchased the system), Dayton's (a regional retail store), B. Dalton Bookseller, and local merchants are participating in

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Photo 4: *Examples of the pictures created on the Viewtron system being run by Knight-Ridder newspapers and AT&T. This system is based on NAPLPS and is capable of some very impressive graphics. (Copyright © 1983 by Viewdata Corporation of America Inc., used by permission.)*

the test. From their farms, ranches, or one of approximately 40 public locations, users may bank at home, send and receive electronic mail, order goods, and get weather, crop, and shopping news along with local and national news and sports. The French system is also being tested in Brazil and Greece.

The French have now consolidated their marketing programs for the U.S. and have announced the establishment of Videographic Systems of America (VSA) to supply potential teletext and videotex clients with complete systems. Thomson-CSF, the major stockholder in the new company, will oversee VSA. CBS and NBC have agreed to use VSA equipment for their NABTS teletext operations.

The Viewtron (Knight-Ridder/AT&T) videotex service to begin this year in southern Florida will offer banking and shopping from home, education, games, puzzles, reference material, an electronic messaging service, bulletin boards, classified ads, and recreational information such as airline schedules, seating arrangements, and community events. The service will also allow users to link up with other databases (see photo 4). Viewtron is currently soliciting advertisers to appear on the system. Advertisers' storage charges for information kept in the Viewtron computer are $1 per frame per week. (A frame is composed of 40 characters by 20 lines.) Advertisers can also electronically mail commercial messages to specific Viewtron subscribers.

Viewtron's first test (July 1980) in Coral Gables involved a total of 204 households and 500,000 frames, although only approximately 18,000 frames were available at any one time.

Test results showed that 90 percent of the participants liked the service and 66 percent thought that the advertisers offered enough information for them to make a buying decision.

Preliminary joint venture agreements have been signed between Viewtron and Affiliated Publications Inc. (*The Boston Globe*), Capital Cities Communications (*The Kansas City Star* and *The Fort Worth Star-Telegram*), and A. S. Abell Publishing Company (*The Baltimore Sun*).

Times Mirror began videotex testing in March 1982, with 150 households having the service delivered through television cable and 150 receiving the service through telephone lines (see photo 5). Of all the services offered—banking, home

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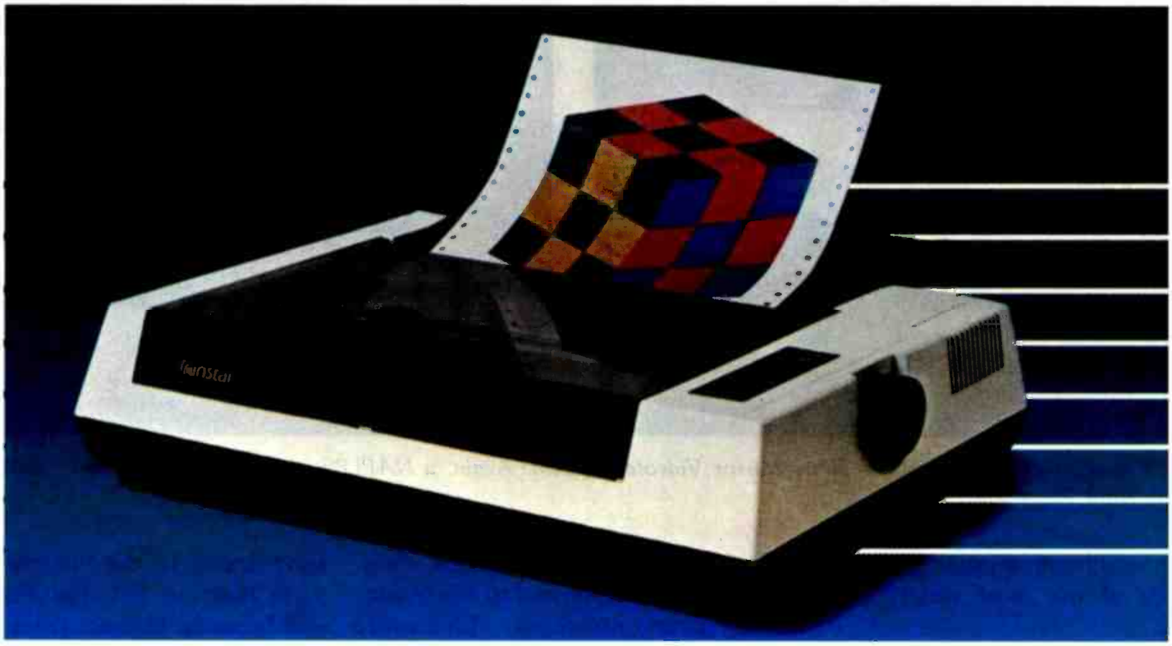

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Photo 5: *Examples of pictures on the Times Mirror Videotex System. Again, a NAPLPS protocol has been used. (Reprinted with permission from Times Mirror.)*

security, and home shopping—games were one of the most widely used features.

Available Services

Personal computer owners or videotex terminal owners can take advantage of some of these interactive services right now. If you have a modem and communications software you can sign up to receive Dow Jones, The Source, Compuserve, Newsnet, and several other services. Although these services do not yet have graphics capabilities, you can keep tabs on almost whatever it is you want to know. These systems may, in time, provide graphics information (and thus become true videotex systems) as soon as a sizable number of videotex terminals appear in the marketplace.

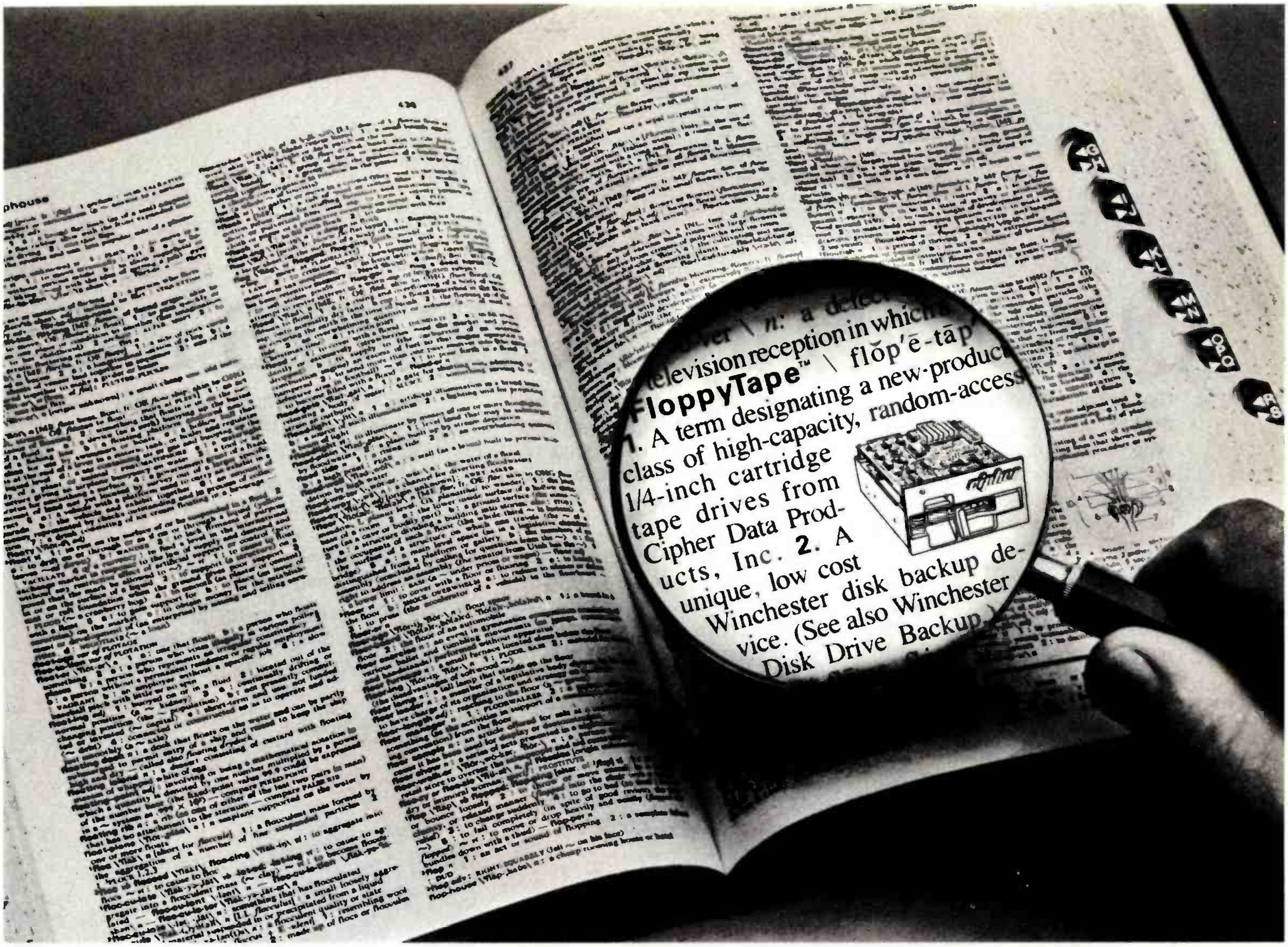
As you probably know, The Source and Compuserve have been offering databases on subjects ranging from wine and food to electronics and communications. Electronic mail, bulletin boards, and special interest groups are among their most popular features. A new system called Delphi, based in Cambridge, Massachusetts, promises a very user-friendly environment.

Another new videotex-like service, Newsnet, a subsidiary of Independent Publications Inc., is run from Bryn Mawr, Pennsylvania. The service allows you to access newsletters on specific topics listed in electronic form or in printed directories. You can then pick keywords relating to your interest in a specific field. Newsnet's computer will find all articles on that subject. Each day you can receive a listing of pertinent new articles that have come into the Newsnet database.

Personal computer owners already have access to the videotex-like services that our fictional Tom Benson will be using 10 years from now. The important difference is that Tom may be able to use them more easily and less expensively. The factors of low cost and ease of use have already proved to be crucial elements in the growth of the personal computer market. It will be interesting to see how these same two factors affect the growth of videotex. It has a potential growth rate as explosive as that of the personal computer industry. ■

About the Author

Darby Miller is director of Information Services Development for Hearst Cable Communications (959 Eighth Ave., New York, NY 10019). She has an extensive background in computer science and electronic media and has written articles for such magazines as Data Communications, Datamation, Videography *and* View.



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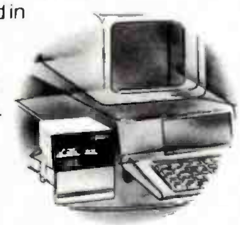

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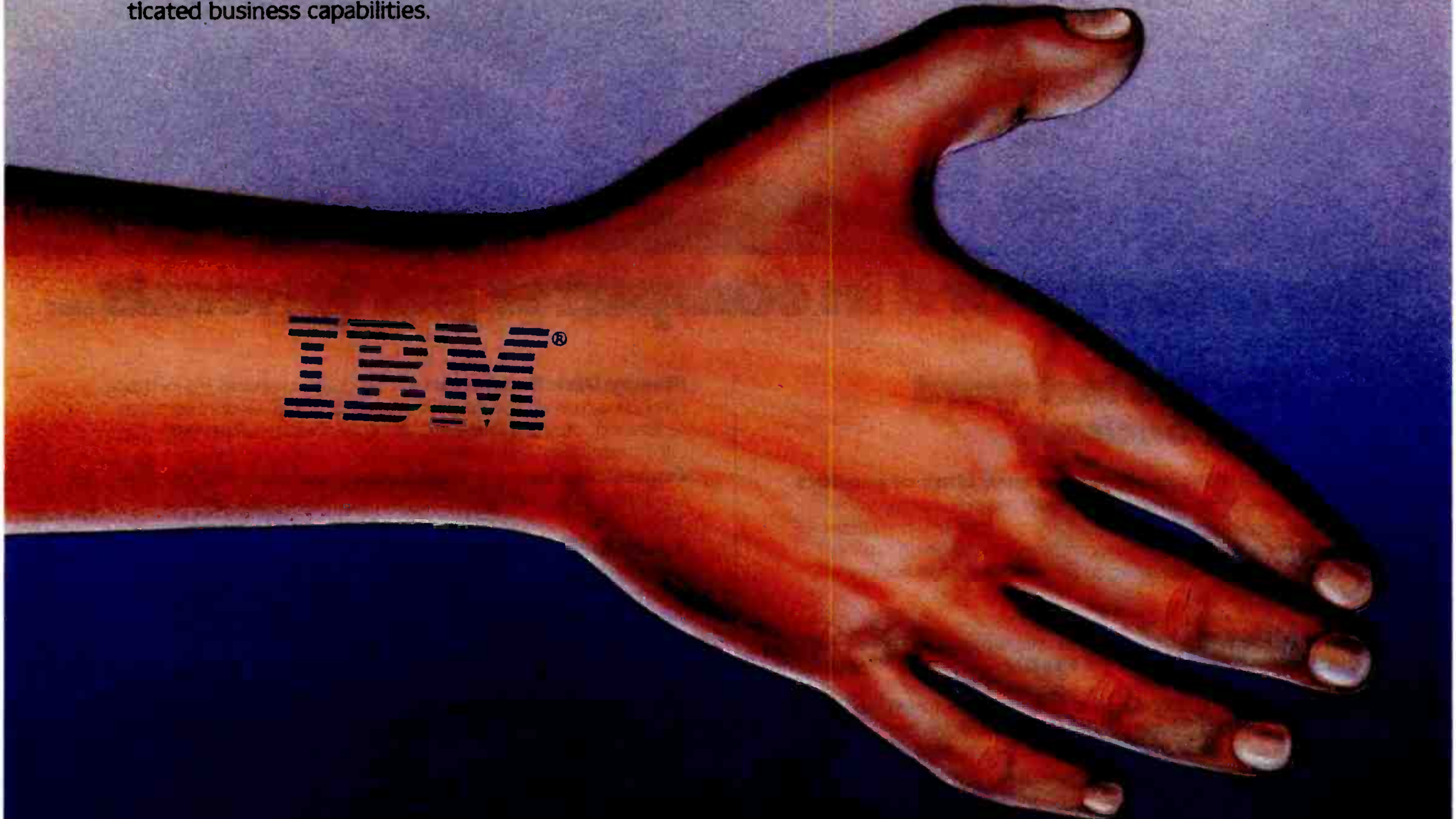

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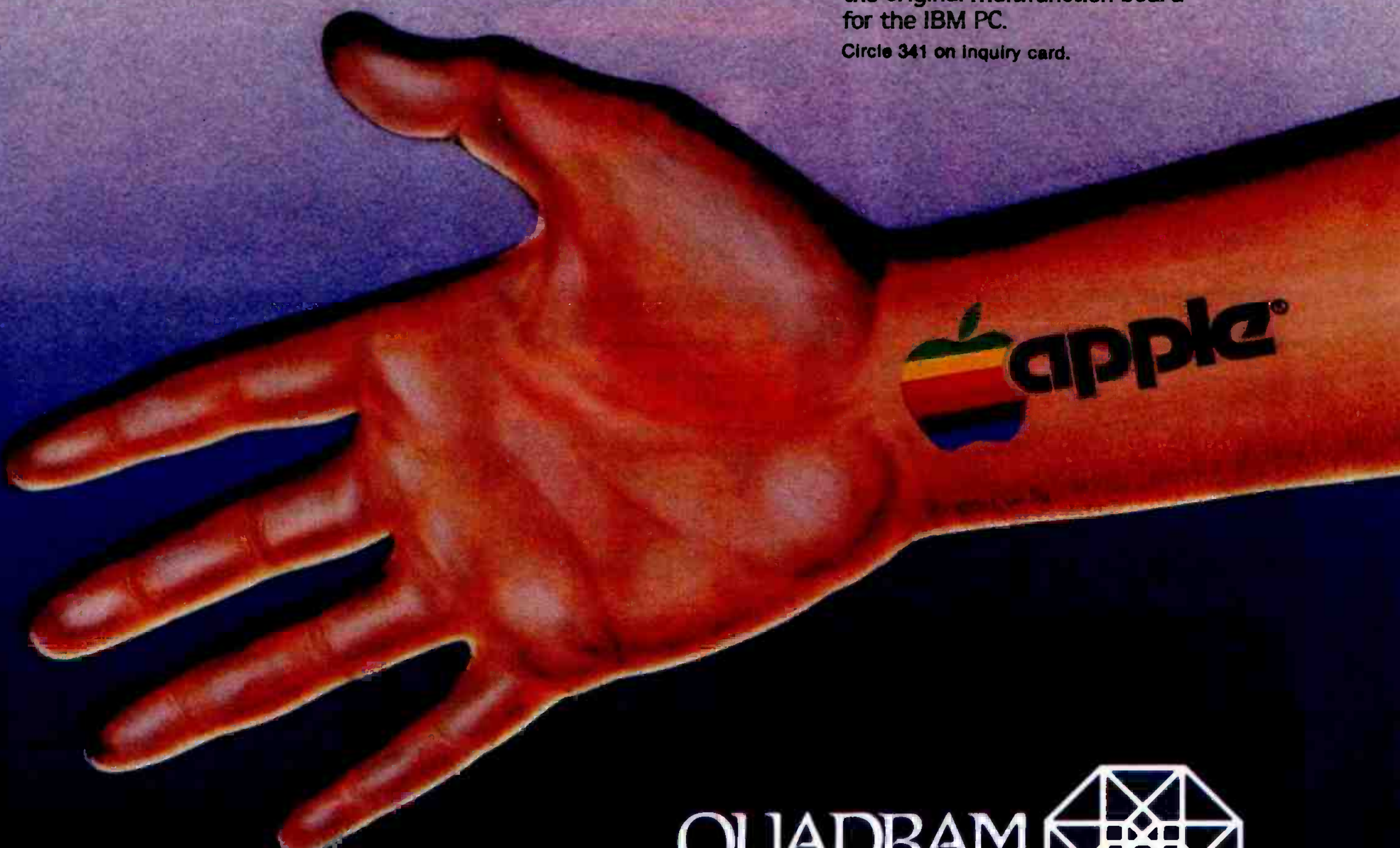

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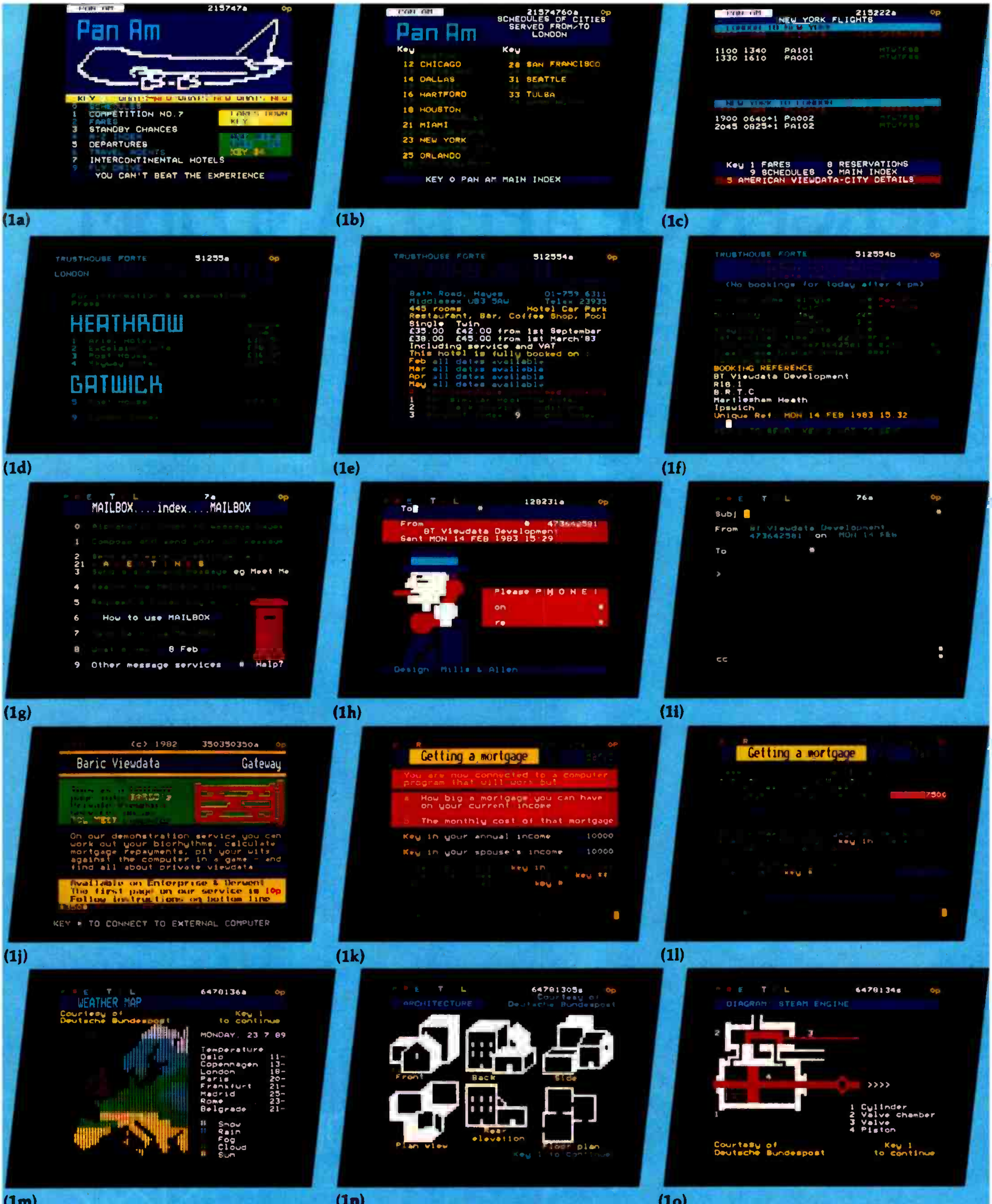


Photo 1: *Samples of Prestel pages (screens) showing the variety of services and the character-graphics-display capabilities. Photos 1a through 1e show a sequence of service-information pages with a response page at 1f. Mailbox-message pages are shown in 1g through 1i. A gateway to services on another computer is shown in 1j through 1l. Character-graphics pages are depicted in 1m through 1o.*

Prestel: The Basis of an Evolving Videotex System

The first videotex system in the world is flexible enough to adopt anticipated technological advances

by Graham Hudson

Prestel is a system for transmitting screens of textual and color-graphics information over the telephone line with two-way communication between the user and electronic information services. This is often referred to by the generic name videotex. Teletext and videotex are two distinct but complementary electronic-information services available primarily in the United Kingdom and Europe. They differ in the way their information is distributed and the types of services they provide, but their color-graphics displays are compatible.

With teletext, television viewers have immediate access to news, sports, travel, weather, and entertainment information. It is telecast as a television signal by the British Broadcasting Corporation in a public service called Ceefax and by independent television companies in a commercial service called Oracle. A special adapter is required to decode the telecast signal and create a page of information with graphics characters on your television screen.

A limited number of pages of information are continuously telecast in a loop, and you select from a menu, or index page, with a remote-control keypad similar to the one on a push-button telephone. The decoder, which can be built into the television, has some intelligence and gets the next telecast of the page of text you've selected. This takes several seconds in some cases. The index page is telecast more often because it is viewed more frequently.

Videotex, also called viewdata, is an entirely separate service that uses telephone lines for transmitting information. Prestel is British Telecom's public videotex system that provides subscribers with information from travel agencies, banks, newspapers, and other information services. Businesses can also use Prestel for private information networks with closed user groups that control the receipt of certain pages of information to a selected group of users.

Prestel was the first, and is still the most successful, videotex system in the world, and many of its features have been adopted by later videotex systems. It differs from telecast teletext systems like Ceefax and Oracle in significant ways. It is faster, provides more information, and is interactive, allowing you to both send and receive information. As soon as you ask for a page of information, a Prestel computer sends it to you over the telephone line at 1200 bits per second (bps) and it appears on your video display. The characters that you type are transmitted to the Prestel system at 75 bps. Hundreds of thousands of pages can be stored with the Prestel system, as opposed to hundreds of pages with a teletext system. You can interact with Prestel to reserve an airplane seat, shop electronically, or send a message to an information service or to another user on the system with electronic mail.

Prestel is available in the United States, but it is not as widespread or popular as The Source or Compuserve information services that offer text but not color-graphics capabilities. The Prestel distributor for the U.S. is Torch Computers Corporation of Woburn, Massachusetts, which also offers a British microcomputer with a built-in Prestel decoding program.

The major videotex system in North America is the Telidon system that was developed in Canada. It has been modified by AT&T, resulting in NAPLPS (North American Presentation-Level-Protocol Syntax). (See the four-part series "NAPLPS: A New Standard for Text and Graphics" that begins in the February 1983 BYTE on page 203.)

Prestel's advantages over NAPLPS are that it is easily decoded by a terminal, requires little display memory or time, is less sensitive to errors in data communications, and costs less. The weak points for Prestel include a dependence on video-display hardware, the current low resolution of the images due to character graphics, and interconnections with printers and plotters.

History and Background

Videotex was born at British Telecom Research Laboratories in the early 1970s from a marriage of computer, communications, and television technology. Prestel began in 1979. Now more than 62 percent (90 percent by the end of the year) of the United Kingdom's telephone population can access Prestel through a local telephone call.

Videotex is an interactive two-way information system. You are sent only the information pages that you request. Also, you can make a response to a page, for example, to make a hotel reservation or to order goods. (See photo 1 for examples of Prestel information pages.) A local Prestel center has a database of more than 250,000 pages of information and acts as a gateway to information on external computers. These other computers can provide services such as online bookings, financial quotations, or banking.

The videotex message facility known as Mailbox on the Prestel system lets you create and store a message on the database for another user. When logging into the system, the recipient is told if there is a message waiting. However, sending textual messages will require the use of an alphanumeric keyboard, not the simple telephone-type keypad. An exciting new scheme launched earlier this year will let the growing numbers of microcomputer owners in the United Kingdom access a telesoftware library on the Prestel database. Known as Micronet 800, the package provides an acoustic modem, decoding software for your computer, and library access.

For mass-market penetration, low-cost terminals were needed. Because

Videotex is an interactive system linked to a large database; teletext, a noninteractive system, provides constantly updated information such as news and weather.

of this, the original terminals were based on television receivers with special-purpose integrated-circuit display controllers. In the United Kingdom a common display standard was developed for videotex and telecast teletext. More than a million terminals using this display standard are in the United Kingdom; several million more are in the rest of Europe.

Teletext is a one-way noninteractive system. All the pages on its database are transmitted cyclically. After a user selects a page, the terminal displays it as it is received. The two services are meant to be complementary: teletext providing a small database of mass-appeal information that is constantly updated (news, weather, television program guides, and sports results) and videotex providing a broad spectrum of in-depth information (timetables, town guides, and consumer reports).

This article examines the features of a Prestel display and discusses ways to implement them using a character generator or bit-mapped display. Some of the features of the new European videotex standard are outlined, including the recently proposed geometric graphic and photographic recommendations.

Display Facilities and Coding

The Prestel display consists of a page with 24 rows of 40 characters. In practice, the top row of the page is used for a header with the information service's name, page number, and page charge. The bottom row can be used for system messages (for example, "Mistake? Try again or tell us on *36"). This leaves 22 rows available for information. The repertoire of 96 alphanumeric characters (see figure 1) is based on the ISO (International Organization for Standardization) character set that is similar to ASCII (American National Standard Code for Information Interchange). Prestel does not specify the actual dot-matrix size or character font.

For producing simple graphics, a set of characters made up from a mosaic of 3 by 2 blocks is provided. Each of the 6 least significant bits of the code used corresponds to one of the six mosaic elements. Characters are normally referred to in a two-number hexadecimal notation that corresponds to their column and row position in an 8 by 16 code table (for example, 4/1 equals the letter "A"). Figure 1 shows the normal way of representing a coding scheme where the interpretation of a single code is dependent on earlier code sequences. The empty code table represents the character set in use. Individual codes are received and decoded with respect to the current character set. The default value is the alphanumeric character set.

Columns 0 and 1 of the code table are used for control purposes such as moving the active position around the display. (The active position is where the next character will be displayed.) This is synonymous with the cursor controls of a video-display unit. The display must automatically wrap around to the next row after 40 characters are displayed. The Prestel central editor terminates short rows (less than 36 characters) using Active Position Down (APD) and Active Position Right or carriage return

DISPLAY ATTRIBUTE SET (C1)

† DEFAULT VALUE
Δ ACTION COMMENCES IMMEDIATELY

	4	5
0		
1	ALPHA RED	MOSAIC RED
2	ALPHA GREEN	MOSAIC GREEN
3	ALPHA YELLOW	MOSAIC YELLOW
4	ALPHA BLUE	MOSAIC BLUE
5	ALPHA MAGENTA	MOSAIC MAGENTA
6	ALPHA CYAN	MOSAIC CYAN
7	† ALPHA WHITE	MOSAIC WHITE
8	FLASH	CONCEAL
9	† STEADY Δ	† CONTINUOUS MOSAIC
10		SEPARATED MOSAIC
11		
12	† NORMAL HEIGHT Δ	† BLACK BACKGROUND
13	DOUBLE HEIGHT	NEW BACKGROUND Δ
14		HOLD MOSAIC Δ
15		† RELEASE MOSAIC

ESC

	2	3	4	5	6	7
0	SPACE	0	@	P	–	p
1	!	1	A	Q	a	q
2	"	2	B	R	b	r
3	£	3	C	S	c	s
4	$	4	D	T	d	t
5	%	5	E	U	e	u
6	&	6	F	V	f	v
7	'	7	G	W	g	w
8	(	8	H	X	h	x
9	)	9	I	Y	i	y
10	*	:	J	Z	j	z
11	+	;	K	←	k	¼
12	,	<	L	½	l	‖
13	-	=	M	→	m	¾
14	.	>	N	↑	n	÷
15	/	?	O	#	o	■

ALPHANUMERIC CHARACTER SET

ESC ALPHA COLOR

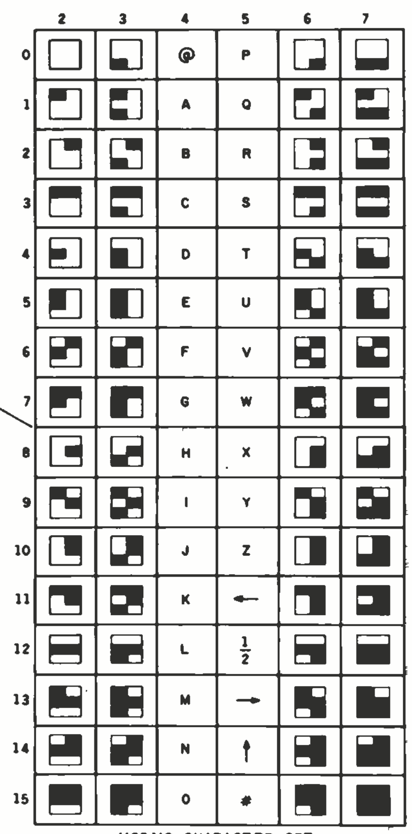
		0 000	1 001
0	0000	NUL	
1	0001		CURSOR ON
2	0010		
3	0011		
4	0100		CURSOR OFF
5	0101	ENQ	
6	0110		
7	0111		
8	1000	ACTIVE POS BACKWARD	
9	1001	ACTIVE POS FORWARD	
10	1010	ACTIVE POS DOWN	
11	1011	ACTIVE POS UP	ESC
12	1100	CLEAR SCREEN	
13	1101	ACTIVE POS RETURN	
14	1110		ACTIVE POS HOME
15	1111		

CONTROL CODE SET (C0)

2 010	3 011	4 100	5 101	6 110	7 111

CHARACTER SET IN USE

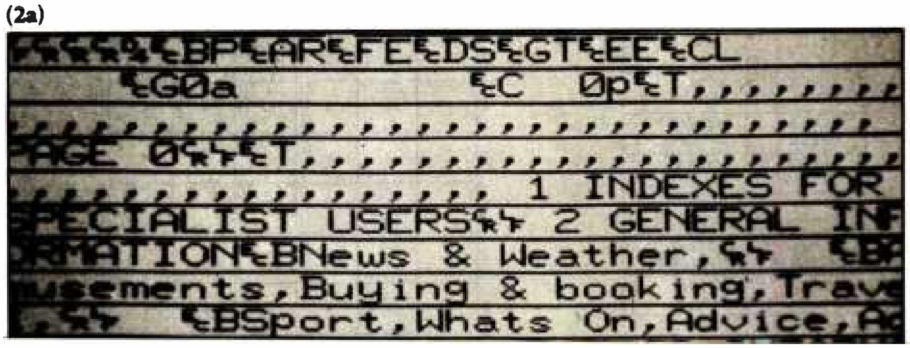
ESC MOSAIC COLOR



MOSAIC CHARACTER SET

Figure 1: *The Prestel alphanumeric and mosaic (block graphics) character sets and the attribute-code table. All possible 7-bit codes are represented on an 8 by 16 table. Each code is usually referred to by its column/row numbers. For example, 0/12 (or 0C hexadecimal) refers to the Clear Screen control code. The code 6/1 can indicate either the character "a" or a mosaic character, depending on what display attributes preceded it. The sequence 1/11, 4/2, 6/1 would produce a green "a." The sequence 1/11, 5/7, 7/15 would produce a solid-white mosaic character.*

(2a)



attributes to their default values as indicated in figure 1. The active position is then sent to the top of the display. Following a Clear Screen command, the terminal should be ready to receive the next character after 30 ms. The null code (00) causes no action to be taken and fills up this time to allow the terminal to clear the display. Other control codes, in-

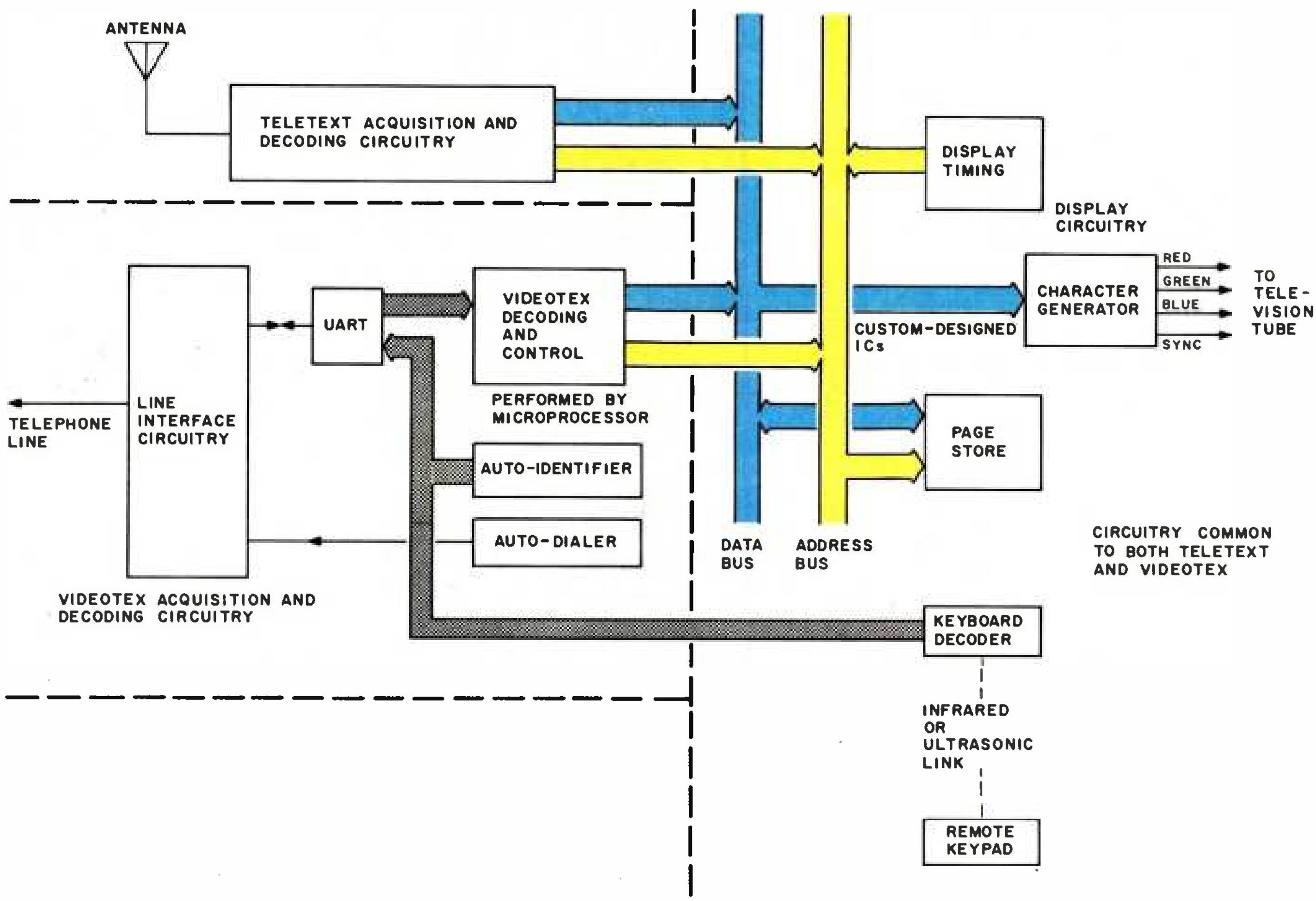


Figure 2: *A block diagram of a complete teletext/Prestel terminal.*

numeric and mosaic graphics sets. The colors available are the eight combinations possible (except for black) from having the RGB (red-green-blue) display-tube electron guns turned on or off. The 3 least significant bits of the attribute code correspond to the logic drive of the RGB electron guns.

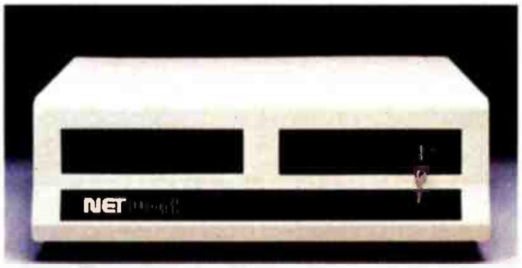
The new background attribute sets the character background color to that of the current foreground. The foreground must therefore be set to another color for subsequent characters to be visible. On a new row, a new background code will immediately change the background color for the rest of the row. The black background code simply sets the downward to occupy two rows by using the double-height attribute. Any characters that exist in the lower row are obliterated, even those below a normal-height character. Also, the entire lower row takes on the background color from the row above. The normal-height attribute makes subsequent character foregrounds normal height.

The separated mosaic attribute causes each element of a mosaic graphics character to split and become surrounded by the background color. This provides a set of large-dot building blocks that have a visual smoothing effect when used for graphics such as maps and portraits. The separated effect is canceled by and displayed in the attribute's position, instead of a space. Release mosaic stops the hold-mosaic effect. Hold mosaic has an immediate effect; release mosaic is effective from the next character position.

Character-Generator Displays

In common with many other text displays, most Prestel terminals use a character generator because this technique is extremely efficient for display memory. A block diagram of a complete teletext/Prestel terminal is shown in figure 2. The distinguishing principle of a character-generator system is that the display is divided into an array of character cells. Codes identifying the character in each cell

May we interrupt the hoopla with a few facts?



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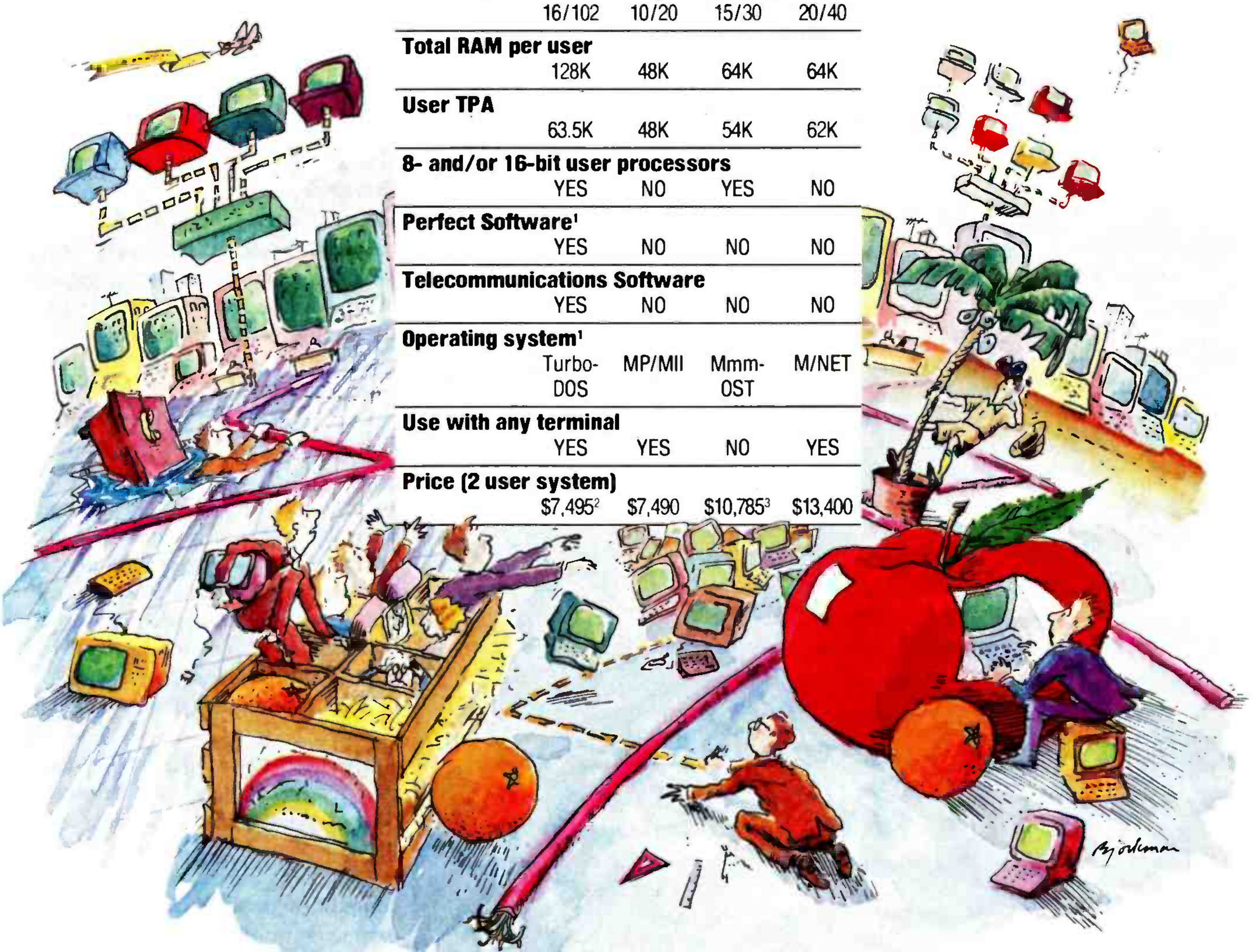
No. users (min/max)	2/8	4/4	1/6	1/8
Winchester formatted Mbytes (min/max)	16/102	10/20	15/30	20/40
Total RAM per user	128K	48K	64K	64K
User TPA	63.5K	48K	54K	62K
8- and/or 16-bit user processors	YES	NO	YES	NO
Perfect Software[1]	YES	NO	NO	NO
Telecommunications Software	YES	NO	NO	NO
Operating system[1]	Turbo-DOS	MP/MII	Mmm-OST	M/NET
Use with any terminal	YES	YES	NO	YES
Price (2 user system)	$7,495[2]	$7,490	$10,785[3]	$13,400



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40 characters needs a page store with 960 locations. With 96 different characters, it has to have 7 bits for each character. In practice, a 1K-byte RAM (random-access read/write memory) is used. Normally, the display position is held in the decoding processor in a row (5 bits for 24 rows) and column (6 bits for 40 columns) count, but this is compacted to a 10-bit number in the range 0 to 959 to address the 1K bytes of memory.

The main component of the character generator is the character-set ROM (read-only memory). A character matrix of 10 by 6 dots is common, allowing 9 by 5 dots for the character foreground that permits descending lowercase letters. The actual address of the line of character dots in ROM is derived from the character code in the page store plus the character-line count. For an interlaced display, character rounding is achieved by comparing two consecutive lines and adding half a dot before or after a whole dot when a diagonal is detected.

The other major function of the character generator is to implement the attributes. For example, the dot color can be generated by holding the 3-bit foreground and background colors from the invoking attributes on the inputs of a multiplexer and controlling their selection by the dot bits from the ROM. Double-height characters are achieved by addressing the same character line on two consecutive display lines. Mosaic graphics characters can be generated directly from the bit patterns of the character codes. For separated graphics, the line of dots is masked on certain lines. All these features are provided on the Signetics/Mullard SAA 5050 chip that is used in the majority of Prestel and European teletext terminals.

The contents of the page store are transferred automatically through the character generator under the control of a display-timing circuit. The timing source is normally a local crystal, sometimes phase-locked to the telecast synchronization pulses if available. This produces dot pulses at 166-microsecond (μs) (6-MHz) inter-

vals that are used by the character generator to push out character dots serially. The dot clock is divided to produce the column addresses for the page store and further divided to produce line synchronization pulses at 64-μs intervals. The line pulses are counted to produce line numbers (1 to 10) for the individual character memory and row numbers (1 to 24) to address the page store. A complete synchronization signal is also produced to drive the display-raster time base when no telecast carrier is available. The teletext timing-chain chip (Signetics/Mullard SAA 5020) incorporates all these clock dividers and the address logic.

Bit-Mapped Displays

Another type of display architecture is frequently used for computer graphics and television pictures: a bit-mapped display. Until recently, its use has been restricted to professional applications because of the relatively large amounts of memory needed to keep track of each dot on the screen. With a bit-mapped system, each display dot is uniquely associated with a bit or bits in the display memory. For a monochrome display, a bit specifies whether a dot is on or off; for a color display, the bits specify the color (3 bits for eight colors) of the dot. (Making a color dot the same color as its background effectively turns it off.) Text and graphics information are converted once, on receipt, into a dot pattern and stored in the bit map. At display time, the bit-mapped memory is simply read directly to the display.

A bit-mapped architecture provides a flexible display on which practically all display features can be performed under software control. A bit map of 240 by 240 dots requires 29K bytes of memory and will display Prestel characters with the same resolution provided by a character generator with a 1K-byte page store. Despite this inefficiency, many microcomputers are available whose character generators do not have the capabilities for displaying Prestel characters but do have either a redefinable character set or bit-mapped graphics that can be used for Prestel. Future generations of videotex, mentioned later, will need a bit map for high-resolution graphics and photographic displays. It may then be desirable to implement alphamosaic characters on the same display.

When a displayable character code is received, each character line is fetched by the processor from the character matrices in memory. Each bit representing foreground or background color is converted to a full dot color (3 bits) and modified according to the attributes effective at the current display position. The resulting dot information is written into the bit-mapped display. A flowchart outlining the decoding process is shown in figure 3.

The receipt of a single serial attribute code can generate a lot of writing into the bit map. For example, on a previously blank row a new background code has the effect of filling the rest of the row with a new

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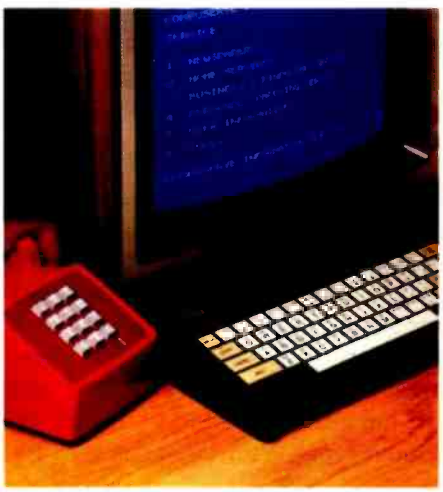

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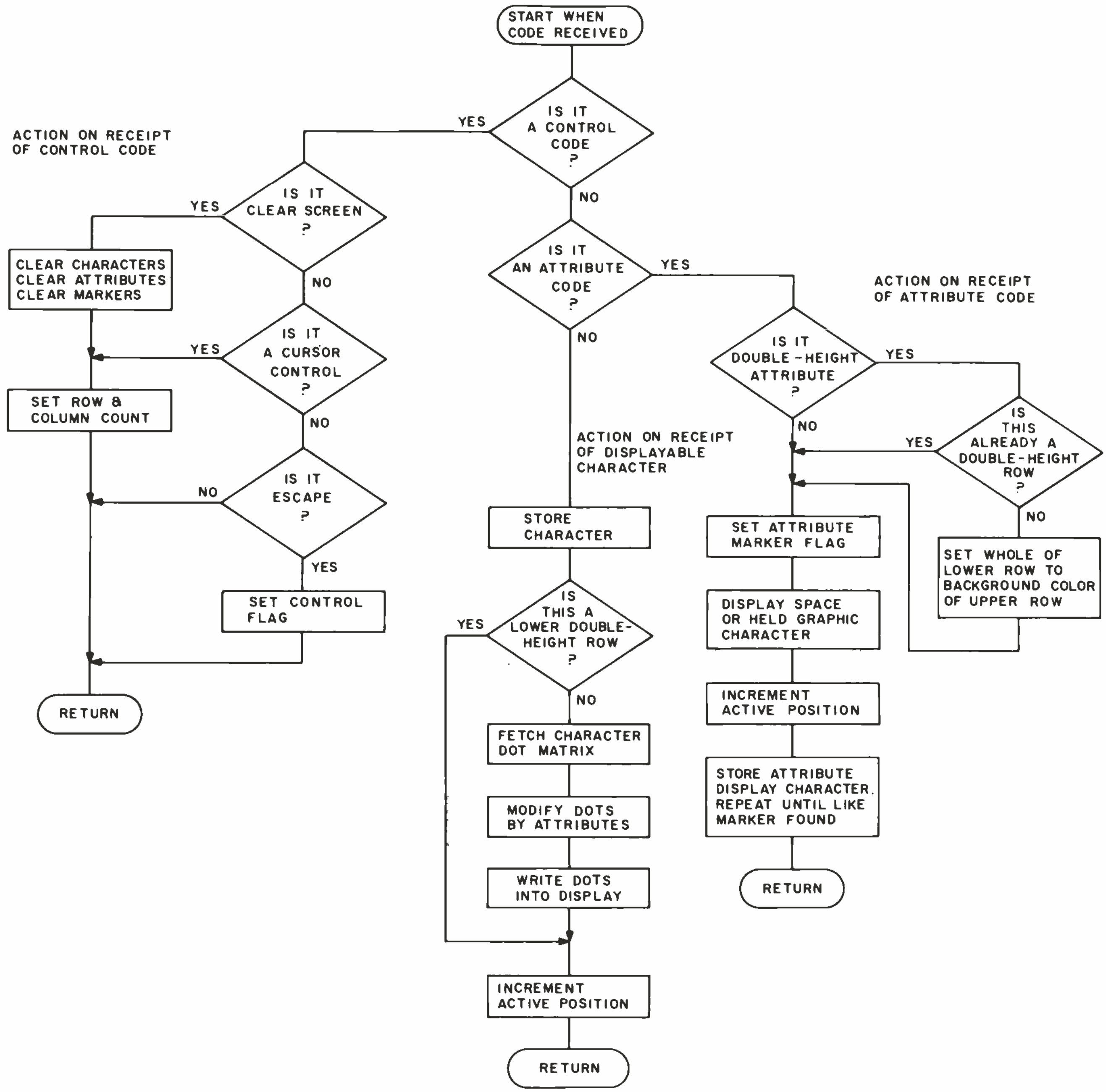

Figure 3: *A flowchart of the Prestel decoding process. Each code received causes one pass through the flowchart.*

background color (up to 40 characters times 60 dots per character equals 2400 dots). If the double-height attribute has been set previously, two rows of characters (4800 dots) would have to be written. That is a lot of data to be transferred in the interval between two codes of 10-ms length.

The decoding can be kept relatively straightforward for a page of information being written from the top left to the bottom right on a previously cleared display. This is the case for Prestel information-retrieval pages. The decoding processor needs only to accumulate knowledge of attributes affecting the current position.

The situation becomes more critical if the active position moves backward and an addition or modification is made to the page. Then it is necessary to know the character and attributes at this position and the range of the effects of these attributes. It is not possible to determine this information from the bit map. Therefore, it is necessary to keep a record of how the page was created. This can take the same form as a character page store. When a new code is sent to a row, the entire row must be decoded and rewritten into the bit map.

Alternatively, an array must be kept of the displayable characters and attributes set for each character position. Another array, known as the marker memory, has a location for each character and a flag bit for each attribute type. This indicates where attribute changes occurred and sets the limit of propagation for each attribute type. With this arrangement,

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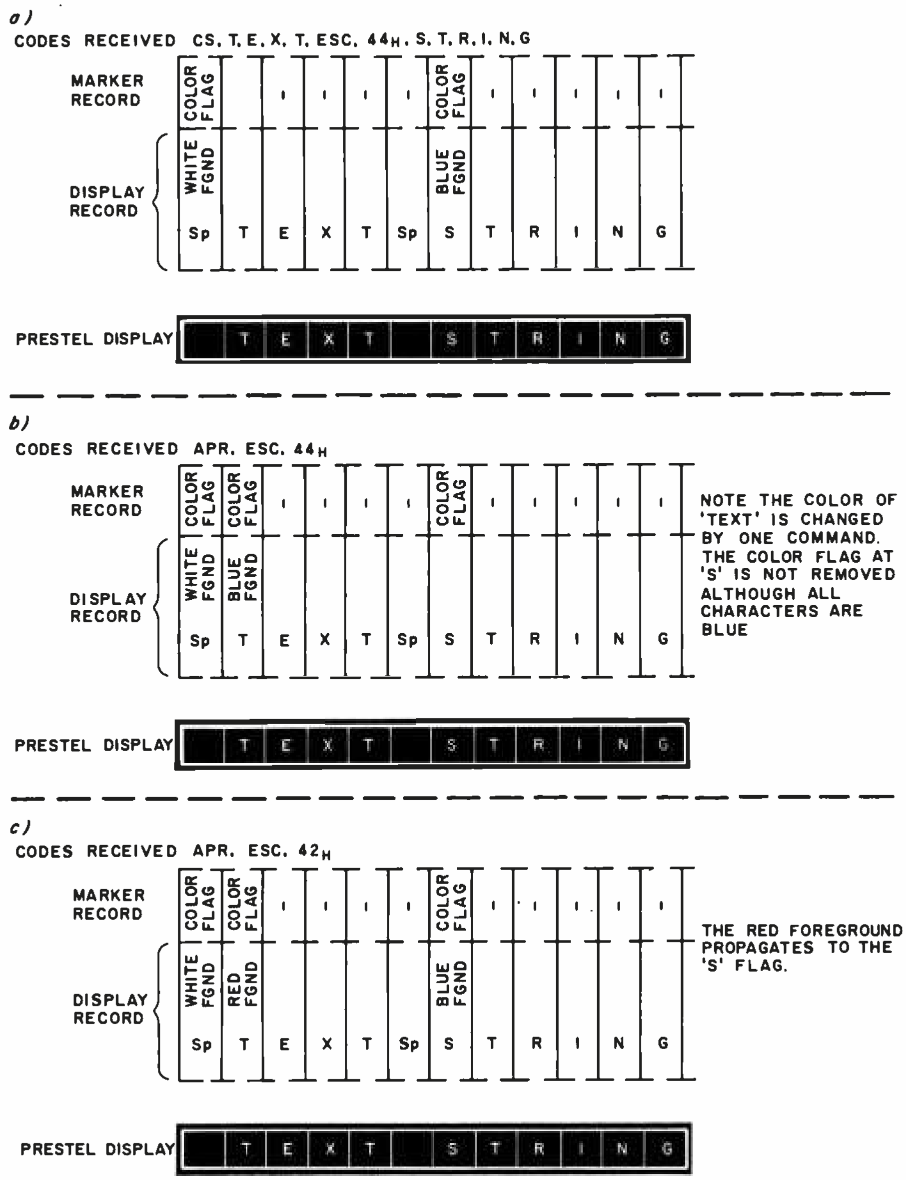

Figure 4: *A diagram showing the immediate effect of a serial attribute and the need for attribute-marker flags. The notation 4/4 is the equivalent of 44 hexadecimal.*

characters, attributes, and attribute ranges can quickly be found without having to decode the whole row. It is not possible to determine the range of an attribute from the attribute value alone (see figure 4).

Flashing characters are difficult to implement on a bit-mapped display. The area to be flashed can be rewritten at the flash rate, but this takes a noticeable time for large areas, not the desired instantaneous change. A technique that gives a limited flash capability is to use an extra bit plane and a color lookup table. Dots that are to be flashed have the extra bit set, and the corresponding locations in the color table are alternately rewritten. The color that the character flashes to can be black or, if only eight foreground/background combinations are to be flashed, a true flash to background color can be achieved. When pairs of colors are alternated in this way, the facility is called blinking.

Microcomputer Displays

Some microcomputers have a complete Prestel display capability, such as the popular BBC microcomputer with its teletext/Prestel character generator. The Apple II computer can become a Prestel terminal with the addition of an Appletel card. The majority of microcomputers in use today can display the basic textual information, although they don't permit all the Prestel features.

The primary requirement is the ability to display 24 rows of 40 characters. If this is not the normal display format of the computer, it may be possible to represent the page using bit-mapped graphics. If you have less than 24 rows on your computer's display, this can be overcome by scrolling or splitting the page display.

Most microcomputers can display the text characters that make up the core of the ISO alphanumeric characters. For characters that do not exist in the computer and for which there is no suitable substitute, the delete (DEL, 7/15, or 7F hexadecimal) character can be used. It is important to display a character for every character or attribute code transmitted in order to preserve the page layout.

The mosaic graphics were originated for use by teletext/videotex and do not exist on many microcomputer displays. It may be possible to make good substitutions, for example, using the block graphics of the TRS-80 Model I/III. Computers with redefinable character sets, such as the IBM Personal Computer, should have few problems simulating all the Prestel characters. With the Apple II, another approach might be using bit-mapped high-resolution graphics. Representing all mosaic characters with a simple character such as an asterisk at least gives an outline of the graphics.

Implementing the various attributes presents more of a problem. Being able to display characters using the foreground color adds greatly to the presentation of the page.

European Videotex

Prestel is a subset of the new European videotex recommendation published in 1981 and, as a subset, is the most inexpensive to implement. The

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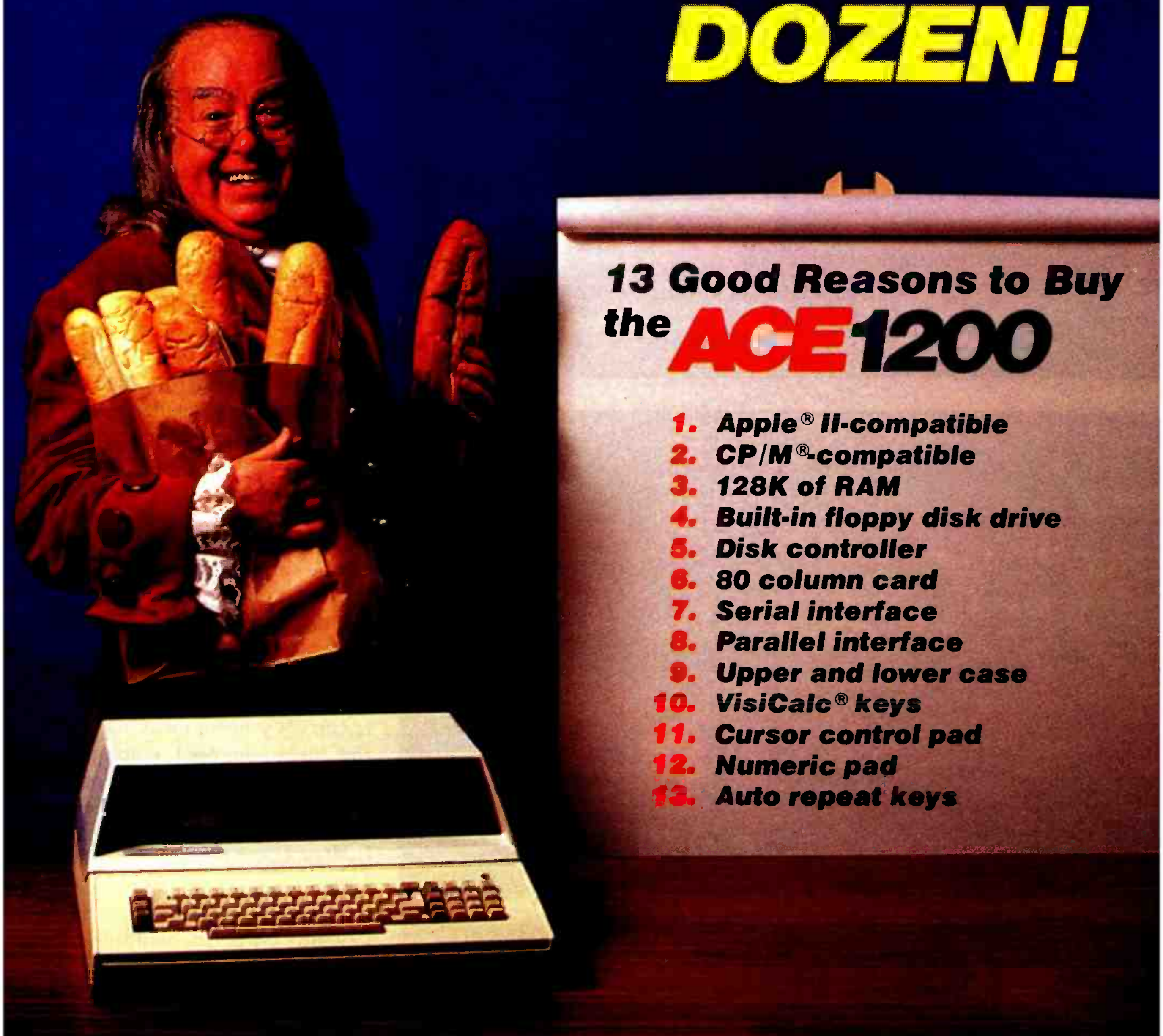

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Photo 3: *Experimental photographic-videotex pages from Picture Prestel.*

CEPT (Committee European des Postes et Telephones) TCD 6/1 recommendation is supported by 26 European countries and is being implemented by many of them.

Future European videotex terminals will have many enhanced text and graphics features as well as being able to display existing databases. An efficient character-generator display chip using a stack architecture for attributes is being developed that uses only 2K bytes of display memory. A repertoire of 331 text characters and 151 graphics characters is provided. Dynamically redefinable character sets (DRCS) infinitely extend the repertoire by allowing character shapes to be sent from the database. Extra attributes include double-width and double-size characters, and simple animation effects can be achieved using three phases of flashing. Display colors are chosen from four palettes of eight colors, all of which can be defined by the database.

The alphamosaic/DRCS recommendation is part of a basic protocol to which new videotex techniques will be continually added as they emerge. A geometric graphics facility is currently being included, based on the highly favored graphics kernel system (GKS) that is expected to shortly become the ISO computer-graphics standard. Several classes of implementation are envisioned—ranging from simple incremental line drawing for a telewriting terminal to beyond GKS to multiple display planes and animation.

The GKS scheme uses a unit-coordinate system similar to NAPLPS. Points can be defined in terms of direct or relative coordinates or by using incremented coding (with increments of the screen size). The powerful, generalized GKS primitives of polymarker (polypoint with a range of point types), polyline, and polygon are used. The transformation primitives of translation, scaling, and rotation are also included. A part of a graphics image can be specified as a segment and then transformed as a whole. An infill command, as well as the normal filled polygon command, lets an area be filled from a seed point to a defined color boundary.

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Overall Quality	2	**5**	3	4	3
Keyboard	3	**5**	2	4	2
Rollover/false keying	5	**5**	3	4	4
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
	24	**39**	26	30	27
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*MICROSYSTEMS—March 1983
**THE ERGONOMICS NEWSLETTER—August 1982

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The greatest advance in videotex-display technology has been the development of photographic videotex. This is the inclusion of a still color photograph of telecast television quality in a videotex page, as shown in photo 3. Photographic videotex is the introduction of digital television technology to videotex.

The problem with photographic images is that their large information content takes a long time to transmit. A studio-quality picture represents more than 1 megabyte of information. In a photographic videotex system, the image is represented by luminance (intensity) and chrominance (color) sample values and is digitally compressed for database storage and transmission. The experimental Picture Prestel system allows for pictures up to one-sixth of the display area to be transmitted in 15 seconds over a 4.8K bps telephone link. Two coding techniques are used: differential pulse code modulation (DPCM) and a Hadamard transform, each providing a compression of 2:1. The latter technique gives a multiscan buildup providing a crude image quickly, which is then refined. A protocol to define the various photographic videotex image parameters and data is being added to the European recommendation.

The Goal

From the simple text and graphics terminals for information retrieval, now emerging are highly advanced graphics and photographic videotex terminals for use in a comprehensive information-communication system. The videotex terminal of the future will be capable of displaying a complete electronic version of the printed page and should also allow for such pages to be created and sent to other terminals. Prestel is a videotex system that can evolve to meet new service needs while incorporating technological innovations. ■

About the Author

Graham Hudson is responsible for advanced videotex terminal development at British Telecom Research Laboratories (Martlesham Heath, Ipswich IP5 7RE, England) and is the United Kingdom's representative at CEPT.

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NAPLPS Standard Graphics and the Microcomputer

Why a graphics standard is important and how it can be implemented in a microcomputer

by Leo Lax and Mark Olsen

NAPLPS, the cacophonic acronym that stands for North American Presentation-Level Protocol Syntax, is the coming thing in communicating information. To understand just why this proposed graphics standard is important, we'll take a look at NAPLPS itself, the incentives for adopting it, how to implement it on personal computers, and the NAPLPS-compatible microcomputer products that are currently available.

What Is NAPLPS?

From its inception, NAPLPS was planned as a set of conventions that would allow the digital communication of graphic information (see photo 1) over low-bandwidth channels—telephone lines, for example. More specifically, NAPLPS provides a method of compressing pictures into a relatively short block of digital data. As a standard, it can be used with equipment from different manufacturers, an advantage every computer owner can appreciate. Moreover, the NAPLPS encoding scheme is compatible with ASCII (American National Standard Code for Information Interchange), which is already in use by most text-handling digital equipment.

NAPLPS describes screen locations using a virtual screen and coordinate system, which makes it possible to use the same data to produce the same image on different machines. It uses PDI (picture-description instructions; see listing 1) to define the geometric properties of the displayed picture, so the encoded result is compact. The protocol maps all codes into the ASCII table to maintain compatibility with existing equipment and standards. To retain the flexibility of a character-oriented (or "mosaic"-oriented) terminal, NAPLPS also incorporates a mosaic definition table (see figure 1) and uses a general character-oriented display technique called DRCS (dynamically redefinable character sets).

The microcomputer industry has several incentives to move toward NAPLPS. Providers of videotex services, observing the success of other information utilities in the personal computer market, view microcomputer owners as potential customers. And the widespread acceptance of

(1a)

Photo 1: *NAPLPS-encoded images shown on two different display systems. The image in photo 1a is a "frame" from the Viewtron Videotex system using a standard home videotex terminal; resolution is 256 by 200 pixels. Photo 1b (opposite page) shows a different NAPLPS-encoded image, displayed on a 500 by 500 screen made by Avcor of Toronto, Ontario.*

(1b)

NAPLPS has prompted microcomputer manufacturers to incorporate the protocol into their machines.

Implementing NAPLPS

You can implement the standard for a microcomputer through hardware, software, or a combination of both. Because the protocol can be viewed as a language and is accessible from other high-level languages, a user with a library of NAPLPS graphics routines can generate videotex images (called frames) by using software alone. Users of popular software packages such as Visicalc will be able to convert their results to easily perceived, colorful images. On the other hand, technology for constructing ICs (integrated circuits) is advanced enough that it is now possible to build a videotex decoder chip. Microcomputer users who have NAPLPS capability can provide others with information that any microcomputer can accept, thus overcoming the incompatibility of many popular best-selling microcomputers.

Features and Functions

NAPLPS allows text and pictures to be encoded in a manner independent of the display device. Pictorial information can be described in terms of points, lines, arcs, polygons, and incremental primitives, all on a Cartesian coordinate system. Thus a low-resolution frame can be shown on a high-resolution display device in such a way that any coarseness due to the encoded resolution of the frame is eliminated. Conversely, high-resolution pictures are displayed at the limit of the resolution of the display device. This independence holds true for other picture parameters, such as color.

The basic features of NAPLPS are the coding of text in ASCII and the coding of geometric images as PDIs. In addition, it is possible to augment text with supplementary characters and diacritical marks and to generate DRCS for use as alternate alphabets. Sequences of PDIs can be defined as macroinstructions before being transmitted, and you can then re-execute them by transmitting a simple instruction rather than the whole sequence.

Coarse pictures may be drawn using graphics characters, which can have various stroke-width, texture, color, size, and rotation attributes. Colors in frames are selected from a palette of 16; the standard allows for more than 512 colors. Unprotected fields may be created on the screen to allow for user input. This combination of features results in a method of communication that is at once flexible and straightforward. (For an in-depth look at the functions of NAPLPS, see Jim Flemming and Will Frezza's four-part series "NAPLPS: A New Standard for Text and Graphics," in the February through May issues.)

Designing NAPLPS Machines

Graphics creation is taking much the same path that text editing has been following for some years. Text editing is now an interactive process in which users, whether they are programmers or not, see the results of

NAPLPS, Past and Present

In past issues of BYTE we have presented a detailed description of a very powerful videotex protocol, the North American Presentation-Level Protocol Syntax (NAPLPS). This article briefly reviews NAPLPS and explores how NAPLPS decoders can be integrated with personal computers.

Listing 1: *PDIs (picture-description instructions) used to encode an image. The actual instructions are shown in listing 1a, while listing 1b explains each sequence. The sequence of the PDIs specifies the order in which the image is drawn; thus, newly defined areas may overlay previously drawn parts. In the listing, x and y refer to absolute coordinates, while dx and dy refer to relative displacements. Operands are encoded as 3 bytes, so the whole image can be described in 108 bytes.*

(1a)

```
SO                        (a)
---------------------------------
CONTROL                   (b)
  blue
RECTANGLE
  x and y
  position
  dx and dy
  displacement
---------------------------------
CONTROL                   (c)
  green
POLYGON
  x and y
  position
  dx and dy
  displacement
  dx and dy
  displacement
       ''
       ''
       ''
       ''
  dx and dy
  displacement
---------------------------------
CONTROL                   (d)
  red
POLYGON
  x and y
  position
  dx and dy
  displacement
  dx and dy
  displacement

       ''
       ''
  dx and dy
  displacement
---------------------------------
CONTROL                   (e)
  green
LINE
  x and y
  position
  dx and dy
  displacement
---------------------------------
POLYGON                   (f)
  dx and dy
  displacment
  dx and dy
  displacement
  dx and dy
  displacmenet
---------------------------------
CONTROL                   (g)
  yellow
ARC
  x and y Start
  position
  mid
  position
  end
  position
---------------------------------
RECTANGLE                 (h)
  x and y
  position
  dx and dy
  displacement
---------------------------------
CONTROL                   (i)
  white
POINT SET
  x and y
  position
---------------------------------
SI                        (j)
  house
```

(1b)

(a) Shift out (SO) to graphics mode.

(b) Draw a blue background covering the entire display area.

(c) Draw a green foreground using a filled 8-sided polygon instruction.

(d) Draw the walls of the house in red using a filled 6-sided polygon instruction.

(e) Draw a green line to define the edge of the roof.

(f) Proceeding from the present beam position, draw the remainder of the roof using a filled 4-sided polygon instruction.

(g) Draw a yellow sun using the arc instruction. Fill in the area between the chord and the end points of the arc.

(h) Draw a yellow door.

(i) Set the color to white and reposition the beam ready for text.

(j) Shift in (SI) to alphanumeric mode and write "House."

their changes immediately. Thanks to the advent of microcomputers, NAPLPS becomes a personal tool for creating and manipulating images.

A NAPLPS-compatible microcomputer must provide these functions:

- Input: keyboard, digitizing tablet, mouse, joystick, or a combination of these devices to create images
- Processing: the computer must be able to interpret the input and let the user manipulate images
- Output: the system should have the capability to both display and transmit encoded frames
- Filing: mass-storage and management of encoded frames are useful in composition and planning

While successful mosaic-type and DRCS-type NAPLPS decoding schemes have been demonstrated, bit-mapping is preferable for two reasons: it provides the picture with the best quality, and its software overhead is lower as a result of color independence. In most current microcomputers that provide color graphics, users must always be conscious of the background color behind their images. For instance, in drawing a thin diagonal of a rectangle, the picture may be accurate only if certain colors are chosen for the lines and the background; the image is affected by the background color because of the way in which the machine's designers mapped the screen into memory.

When NAPLPS is implemented in a bit-mapped architecture, no pixel (picture element) is affected by the color of its neighbors; background color and foreground color are neither interrelated nor interdependent. You can lay any color from the palette over any other without concern for the colors of the adjacent pixels.

Some Current Implementations

One of the first implementations of NAPLPS was in a dedicated decoder (the Norpak MK IV) that incorporated a 6809 microproce
videotex display generat
also produced the firs
widely used NAPLPS fra

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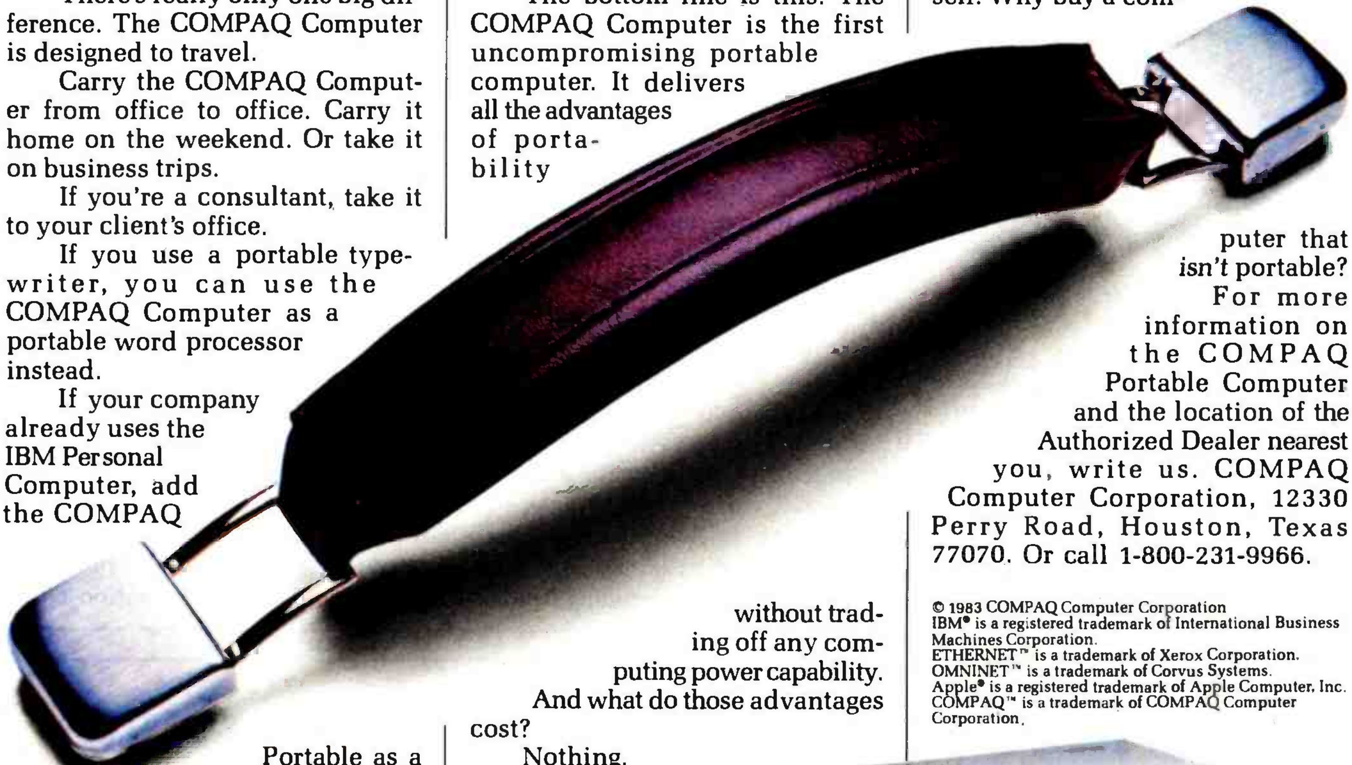

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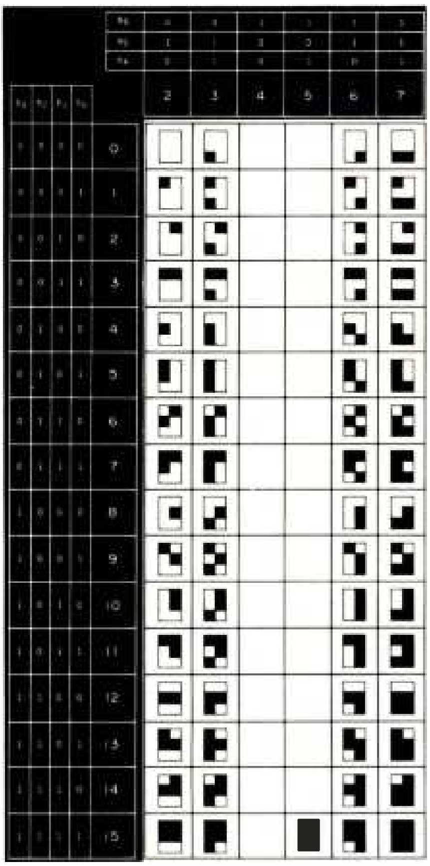

Figure 1: *Mosaic shape table. Each of these blocks may be used as any normal ASCII character would.*

terminal—its Information Provider System (IPS2)—a desk-like unit that provides two video screens, two 8-inch floppy-disk drives, and a small minicomputer to drive the videotex display processors and enable very quick frame creation, immediate-feedback editing, and data storage.

There are three principal variations on the theme of NAPLPS implementation in a microcomputer: the dedicated microcomputer, the add-on card, and the software package. One example of each follows.

Norpak GC-1000: One way to implement NAPLPS in a microcomputer is to design the computer from the ground up to incorporate videotex hardware and a bit-mapped display. This unit provides the "standard" videotex resolution of 256 by 200 pixels via an integral color video monitor. With custom software, RS-232C communications ports, and a keyboard with programmable keys, the GC-1000 is fully equipped to receive and display NAPLPS information from external sources and to generate frames in a stand-alone mode. Further, its integrated design includes two 5¼-inch floppy-disk drives to store images, develop programs, or load videotex from a database or other microcomputers. Its 6809 microprocessor and emulation of Digital Equipment Corporation's VT52 video terminal make the GC-1000 an all-purpose personal machine rather than simply a dedicated frame-creation or decoding device.

Telidon Graphics System (TGS) for the Apple II: The Apple II TGS is an excellent example of a truly personal videotex system. It provides frame creation, decoding, and communications software that enable the system to talk to another Apple so configured (see Rich Malloy's "Commentary: Personal Computers and Videotex" on page 114). Most people consider communications software crucial to a truly interactive and useful videotex system.

The TGS is designed for use on Apple II or Apple II Plus computers with 48K bytes of RAM that run DOS 3.3 with at least one disk drive. A modem data communications system would also be necessary for communication with remote Apple systems or videotex databases. Fast and easy marker control for frame creation and editing can be provided with an optional joystick or tablet.

The TGS package consists of an interface card, incorporating a 6809 microprocessor with serial interface connector, one 5¼-inch floppy disk, a serial-interface connector mounting kit, and a reference manual.

Three graphics system programs are stored on the floppy disk. Create/Edit/Communications is a stand-alone program that enables the user to interactively create, edit, and communicate pictures. Also provided are a variety of frame-creation com-

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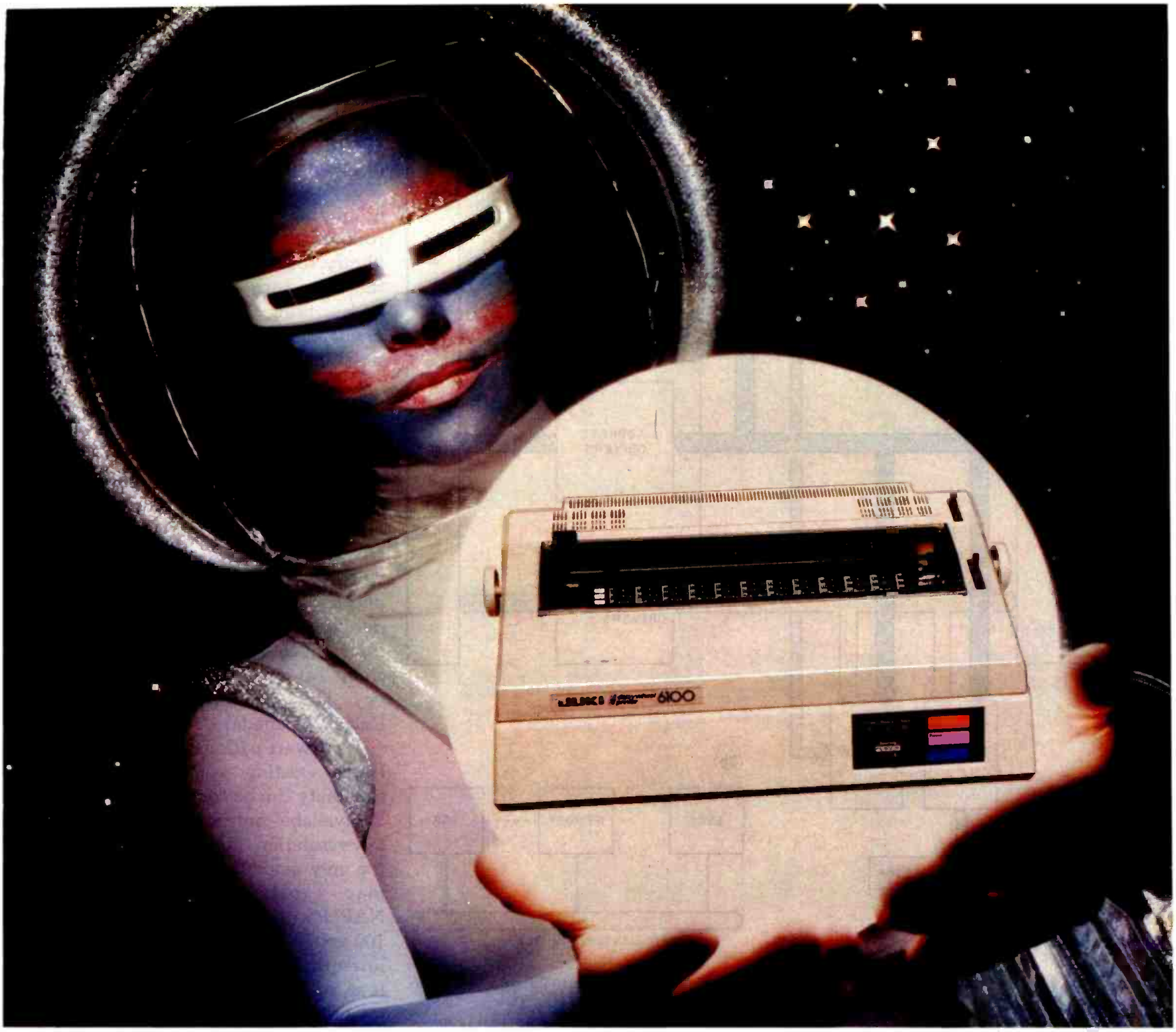

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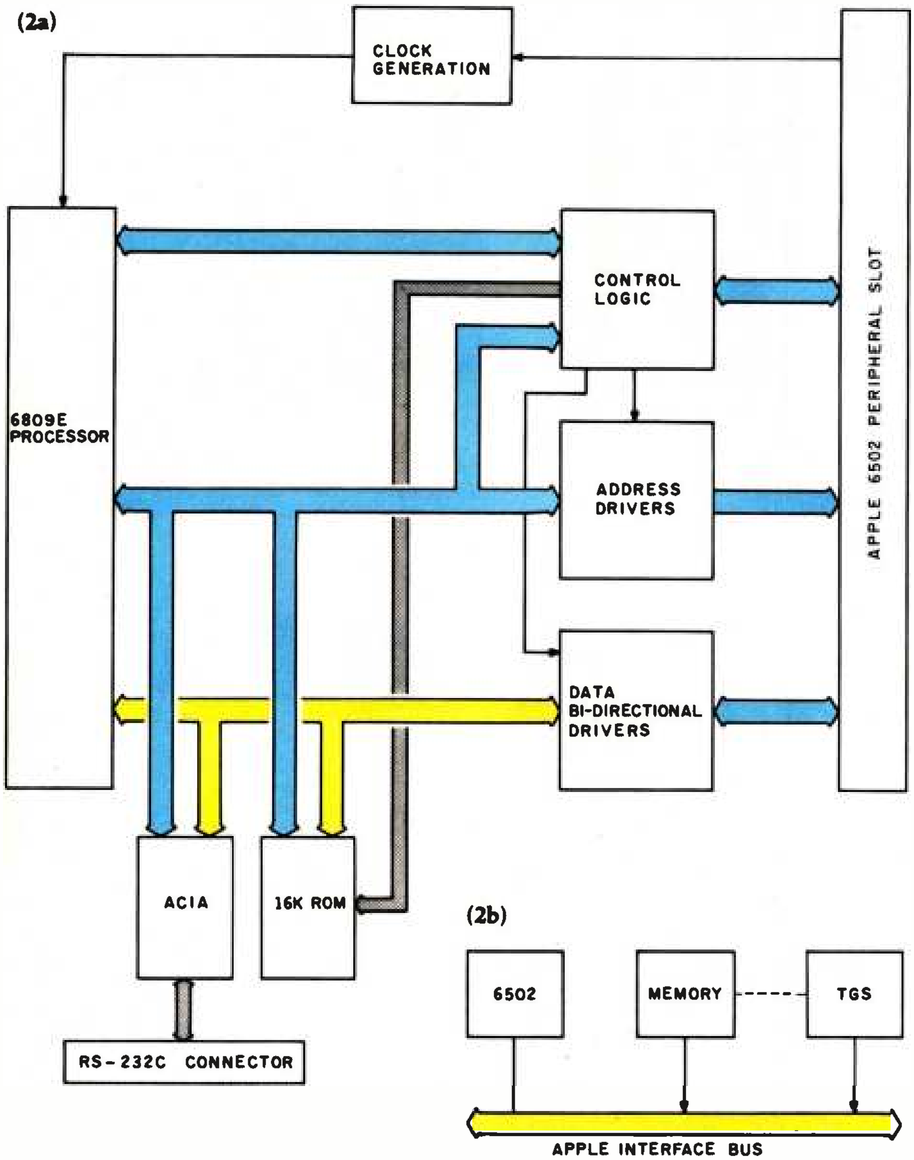

Figure 2: *Block diagrams of the Telidon Graphic Systems card (figure 2a) and how it interfaces to the Apple II (figure 2b).*

mands that concern the basic graphic primitives, colors, text sizes, and text orientation. Frames created with the system or those received from other Apple TGS systems may be edited with this program.

In the Edit mode, you identify a graphic element and can move, erase, copy, or change its color. Text characters or lines of text may be inserted and deleted. The communications feature of the program enables the user to send or receive NAPLPS information to or from other Apple computers fitted with the TGS. Picture data is available either through the Apple internal peripheral connectors for the Hayes Micromodem or through the interface card integral RS-232C serial interface for direct connection or stand-alone modems. A disk-file handling feature permits pictures to be saved, recalled, or deleted from the disk.

The Videotex Terminal program transforms the Apple II into a NAPLPS videotex terminal that can communicate with a remote database. Through keyboard commands users can enter their account numbers or other information giving them access to videotex databases, call up database subject lists or menus, search through the available material for required information, hold it for review, and store locally on disk any pages required for later reference.

The Graphics Routines Library program lets anyone experienced in 6502 Assembler or Apple BASIC programming create pictures using routines called from the disk. The library routines perform a variety of functions such as displaying screen images using the drawing primitives or enabling data transfers through the serial interfaces.

Figure 2 is a block diagram of the interface card and the Apple TGS System.

IBM Personal Computer: There are three NAPLPS implementation options for the IBM Personal Computer. First, a software package can be created to generate NAPLPS data, whether it's in a library or a full applications package that, when sent out to a decoder, will display pictures. Such a package is available from Tayson Information Technology Ltd., a company based in Calgary, Canada.

A software package designed to use IBM's existing graphics-displaying capability can be created. This would be available only on the computer's low-resolution mode because that's the only mode that provides full bitmap capability. The resulting NAPLPS resolution would be 160 by 100 pixels. Although the resolution is lower than the usual 256 by 200, there is an advantage to this option: videotex implementation can be packaged in one machine.

Finally, a proper bit-mapped hardware display generator can be developed for the IBM Personal Computer. This would provide a minimum resolution of 256 by 200 and all-in-one frame creation, editing, and decoding. The advantage of this option is the PC's 8088 microprocessor, which provides the speed and accuracy required by NAPLPS and a memory-addressing capability large enough for the necessary code and video RAM (random-access read/write memory). Implementing this option would be more cost effective than the same option for the Apple II because you can use the microprocessor already in the machine to share

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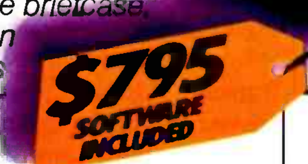

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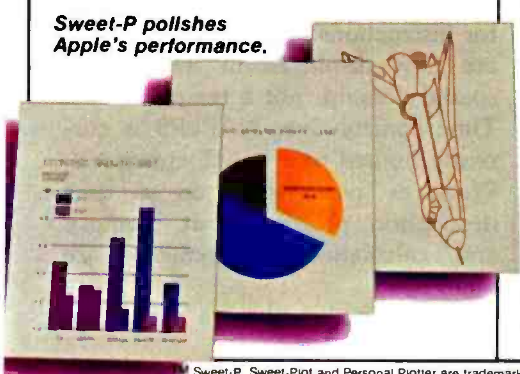

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the burden of memory and computational power needed for decoding.

Other Implementations

Intel and NEC (Nippon Electric Company) provide the next step in the NAPLPS evolution. Their GDC (Graphics Display Controller) chip (Intel 82720, NEC uPD7220) not only takes care of low-level details like refreshing the display but also accepts high-level commands such as Draw a Line, Draw an Arc, Draw a Rectangle, Draw a Character, and so on, and draws the dots on the screen.

Because the processor doesn't have to spend time figuring which dots to draw, it can receive and interpret NAPLPS commands or process data.

Although the GDC chip is significantly closer to providing NAPLPS capabilities in hardware than previous display controllers, some software is still required to convert NAPLPS commands to commands the GDC understands. Digital Research has already introduced software that does this, and several other companies such as Norpak are developing competing products.

Obviously, future generations of VLSI (very large-scale integration) graphics chips will come closer and closer to providing the complete set of NAPLPS capabilities in hardware. Designers will offer higher and higher levels of system performance providing users with faster and faster computer systems. They will reduce the number of chips required to implement a system to a minimum, reducing the cost of computing power to the user. Fortunately, users who embrace these standards will be able to transport software from system to system as they upgrade.

Future Developments

Several enhancements to current NAPLPS implementation are under development.

Photographic data generation, storage, and transmission using NAPLPS has been demonstrated but is still in the prototype stage. The machine that has this feature must perform pattern recognition in order to encode the information and pattern synthesis for geometric shapes, but the realism required for photographic reproduction means more processing power than most of today's consumer-priced decoders or microcomputers offer.

Sound for NAPLPS, whether voice synthesis or musical tones, is also being examined. One question asked is, Why encode sound when you can transmit it now by telephone? An answer is that if a means of encoding sound digitally (through bandwidth compression) were found, clarity of sound superior to that of telephone lines could be provided over longer distances.

Animation currently presents problems for NAPLPS implementation but will exist in the future. NAPLPS coding does not contain time-descriptor instructions. Sequences of images are now displayed in terms of a spatial domain, not a temporal one. Time control over NAPLPS is currently limited to a WAIT command. Work is progressing on a time description protocol, but memory and calculation requirements are high.

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plication of videotex in the future. NAPLPS currently provides a limited facility to personalize or customize the decoder to specific applications; data can be communicated using a macroinstruction and invoked for local use. More useful, however, would be the downloading of both PDIs and the processes that manipulate them so that users could interact with the pictures using someone else's definition of the manipulation process. Thus telesoftware would provide both pictures and the tools (programs) to manipulate them.

Highly device-dependent telesoftware is now available. Still to come is a general-purpose definition of software such that it will run on any microprocessor. (The Pascal p-System definition provides a device-independent telesoftware vehicle but is restricted to the facilities provided in the Pascal language.) Although general-purpose telesoftware can never be all things to all people, application-dependent telesoftware will flourish, irrespective of the machine, for certain standard microcomputer applications.

Conclusion

NAPLPS is an efficient protocol for the creation, storage, and communication of graphic and textual information. Because it is hardware independent by design, it will be implemented on an increasing number and variety of consumer-oriented devices. Proliferation of the graphics protocol will reduce the cost of its implementation as a result of such efforts as VLSI development, mass production, and old-fashioned marketing competition. The ultimate winner in this logical progression is the user, who will be provided with the most cost-effective graphics-communication vehicle available and will have a choice of implementations, costs, and applications. The old "open system concept," in which anyone talks to anyone else on any terminal, will be revived, using the two newly rediscovered tools that make it ideal: color graphics and the personal computer. ■

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Privacy and Videotex Systems

Two-way services bring with them the potential for abuse

by Richard M. Neustadt and M. Anne Swanson

Midway through George Orwell's 1984, *the hero meets an old man and asks him how "Big Brother" got started. Things began to go wrong, the old man answered, when someone invented two-way television.*

Advances in telecommunications promise to bring all sorts of conveniences to our doorsteps. We'll be shopping, banking, and working from home. We'll have computer-controlled electronic mail, burglar and fire alarms, and medical alerts, among other things. But along with this array of new services and products comes a potential for abuse.

The possible threat to privacy that home video and computing services pose is beginning to worry some people. The growth of nationwide videotex systems, whether they operate over cable TV or telephone lines, presents two major causes for concern. First, companies that sell electronic information or provide transactional services such as home banking and shopping will be able to compile dossiers on their subscribers. This information could be misused. Second, the proliferation of electronic transfer of information raises new questions about wiretapping.

Data Collection and Disclosure

The current debate focuses on the collection and possible misuse of subscriber records. Most companies that provide videotex services generate files on subscriber behavior as a matter of course. For instance, if the system operator provides information and charges his customers on a per-page basis, then his computer must keep a record of every video page subscribers request. If the system is used for transactions such as shopping or banking at home, the retailer or financial institution must keep a record, and the cable or telephone system operator may want to keep its own record as protection against claims of error.

Most companies that provide videotex services generate files on subscriber behavior as a matter of course.

Of course, similar records have always been collected by banks, hospitals, insurance companies, and other institutions. But with videotex systems, more records are being collected in one place. Moreover, computer files are easier to obtain than original documents.

The concern about collection of records leads to another issue: the possible disclosure of private information on consumer behavior. System operators may want to sell this data to retailers, pollsters, direct mailers, or credit investigators. Such information is commercially valuable, as indicated by the similar active market in magazine subscription lists.

The action of a theater owner in Columbus, Ohio—where Warner-Amex runs its interactive Qube service—is an example of data disclosure. The owner of the theater subpoenaed lists of people who had watched "adult" movies on cable TV in order to defend himself against obscenity charges for screening those movies in his theater.

Protecting Privacy

Without a law or service contract to the contrary, company records belong to the company that collects them, not to the subscriber. The United States Supreme Court established this principle in 1976 when it held that a consumer had no constitutionally protected interest in his bank records that would enable him to challenge their release to government officials.

In the last two years, however, a movement has taken wing to legislate protections for those records. California, Illinois, and Wisconsin have passed privacy laws, six other states are seriously considering such measures, and the U.S. Congress may well pass a privacy law next year. While most of these bills are aimed at cable TV, the Illinois law and several of the proposed bills also cover two-way services provided over telephone lines. In addition, most cable TV franchises issued in recent years include privacy rules.

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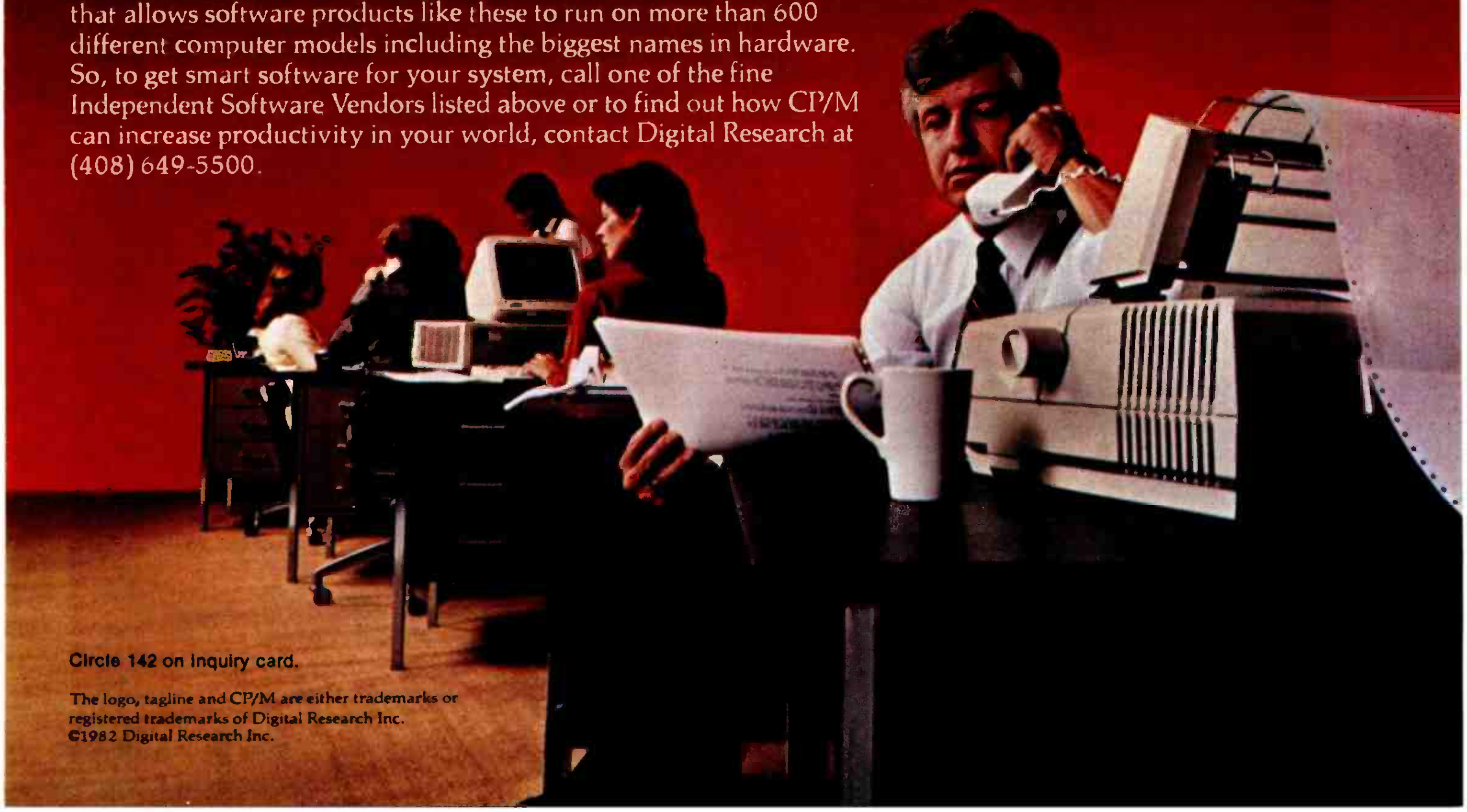

Circle 142 on inquiry card.

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The central aim of this legislation is to require the system operator to obtain the subscriber's consent before collecting information. In most cases, collection without consent is allowed only for purposes of billing, providing a service like at-home shopping, or protecting against unauthorized reception or other services.

The measures vary on specifics. The Wisconsin law goes so far as to require cable operators to offer subscribers a free on-off switch controlling the interactive service. Some of the pending bills require system operators to acquire liability insurance to cover any suits based on violation of their privacy provisions.

Many people in the videotex field feel that all this legislation is unnecessary. They argue that there has been no evidence of abuse and that system operators are hardly likely to offend their customers by invading their privacy. These companies make a strong argument that we should wait to set rules until we know more about the market and the technology.

Legislation is beginning to look inevitable, however. And when it does pass, the biggest problem for the videotex industry will be the motley of state and local rules and the often ambiguous wording of laws. The differences from law to law would, for example, require the operator of a system serving several states to maintain separate databases and procedures for each state—a costly proposition.

Some companies providing interactive services see self-regulation as the best way to allay subscriber concerns and avoid a patchwork of conflicting rules. Two large cable firms—Warner-Amex and Cox—have issued codes of behavior regarding privacy. The National Cable Television Association and the Videotex Industry Association have formed groups to draft industry-wide guidelines. Meanwhile, there is increasing support for a uniform standard, set by Congress, to preempt state and local rules.

Interception

In the case of interactive systems, several kinds of interception are possible. An eavesdropper—or a law-enforcement agent—could put a physical tap on a telephone line or dial into a central computer that transmits messages and keeps records. A cable subscriber could use special equipment to listen on his cable and pick up signals addressed to or transmitted by other subscribers.

Federal law provides criminal sanctions against unauthorized interception of wire communications and regulates legal wiretapping by law-enforcement authorities. The law allows government agencies to wiretap, but only with a court order—which the courts are to grant sparingly—or, if national security is at issue, pursuant to an order from the Attorney General.

Unfortunately, the drafters of this law—who worked on it almost 15 years ago—did not anticipate advances in technology, and the law now has two large loopholes. First,

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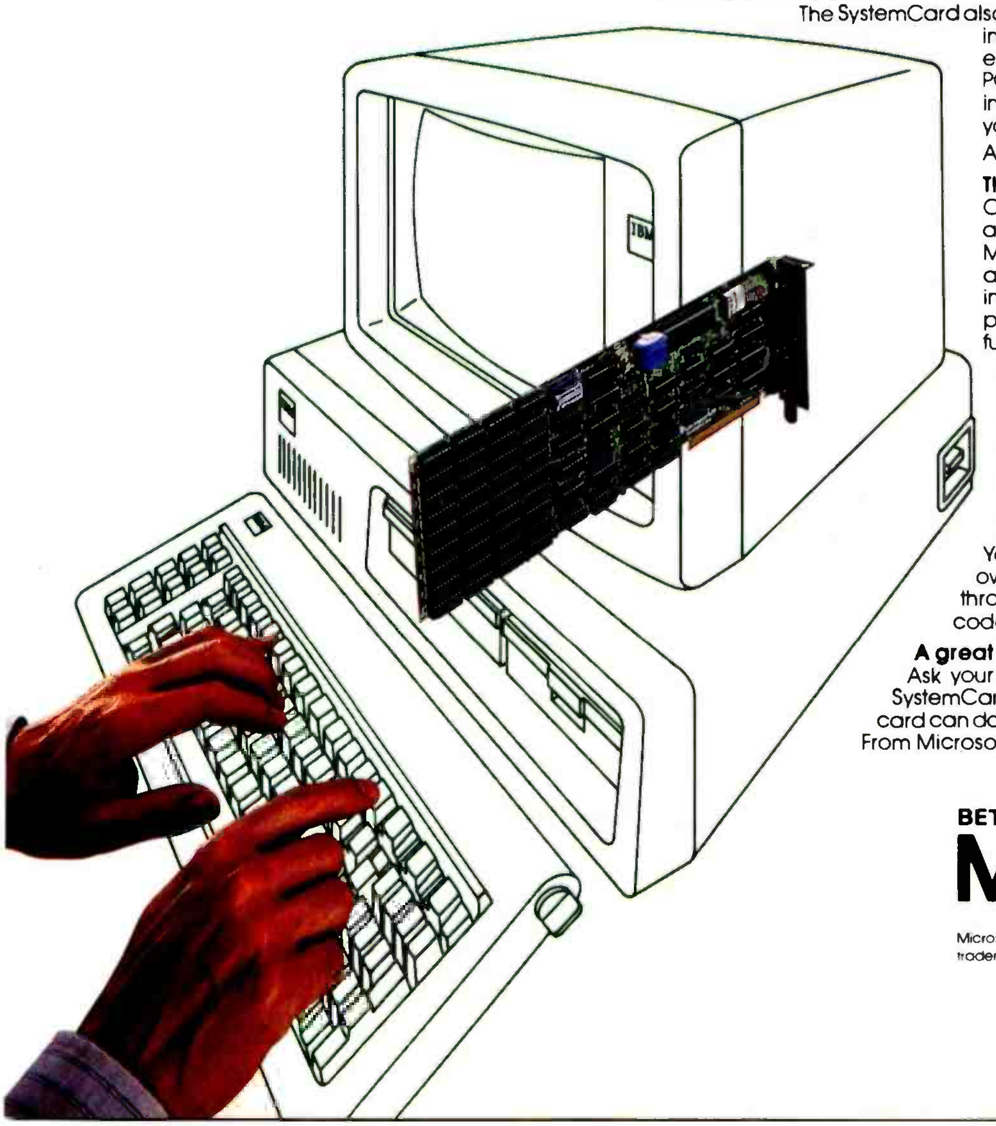

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the law covers only "aural interception," so it does not seem to apply to eavesdropping on data and text transmissions, such as electronic mail. Second, the law defines "wire communications" as transmission provided by common carriers such as the telephone company—probably omitting most cable services.

Legislation pending in Congress addresses both problems. Senate Bill 66 forbids any private person or government body from intercepting any broadband communication unless authorized to do so by the system operator, program originator, or federal law. (The provision does not specify whether law-enforcement investigators would use a regular search warrant or would have to meet the wiretapping law's strict standard to get court permission for nonaural interception.) This same proposal defines cable transmission as "wire communications" so as to include them within the law's scope.

It is too early to tell whether the privacy legislation pending in Congress will become law. If it does, it would preempt similar state regulation and would provide a unified substitute for the hodgepodge of different state and local rules. Although the federal proposal is currently part of a bill that focuses on cable systems, it is drafted broadly enough so that its provisions could be interpreted to include telephone-based services as well.

In the meantime, industry attempts at self-regulation on the privacy issue will increase. Most system operators are anxious not to scare their subscribers—it's hard enough to sell a new product without introducing fear into the equation. As a result, the Orwellian scenario may remain more fiction than fact. ■

About the Authors

Richard J. Neustadt is a partner in the law firm of Wiley, Johnson and Rein (1776 K St., NW, Washington, DC 20006). His recently published book, The Birth of Electronic Publishing *(Knowledge Industry Publications, 1982), touches upon privacy and interactive video services. M. Anne Swanson is an associate with Wiley, Johnson and Rein.*

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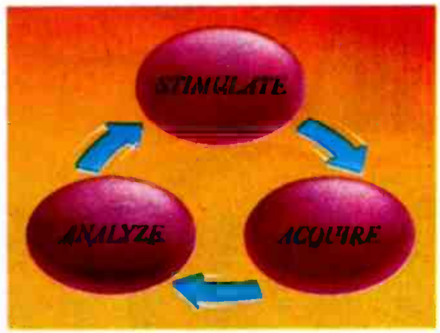

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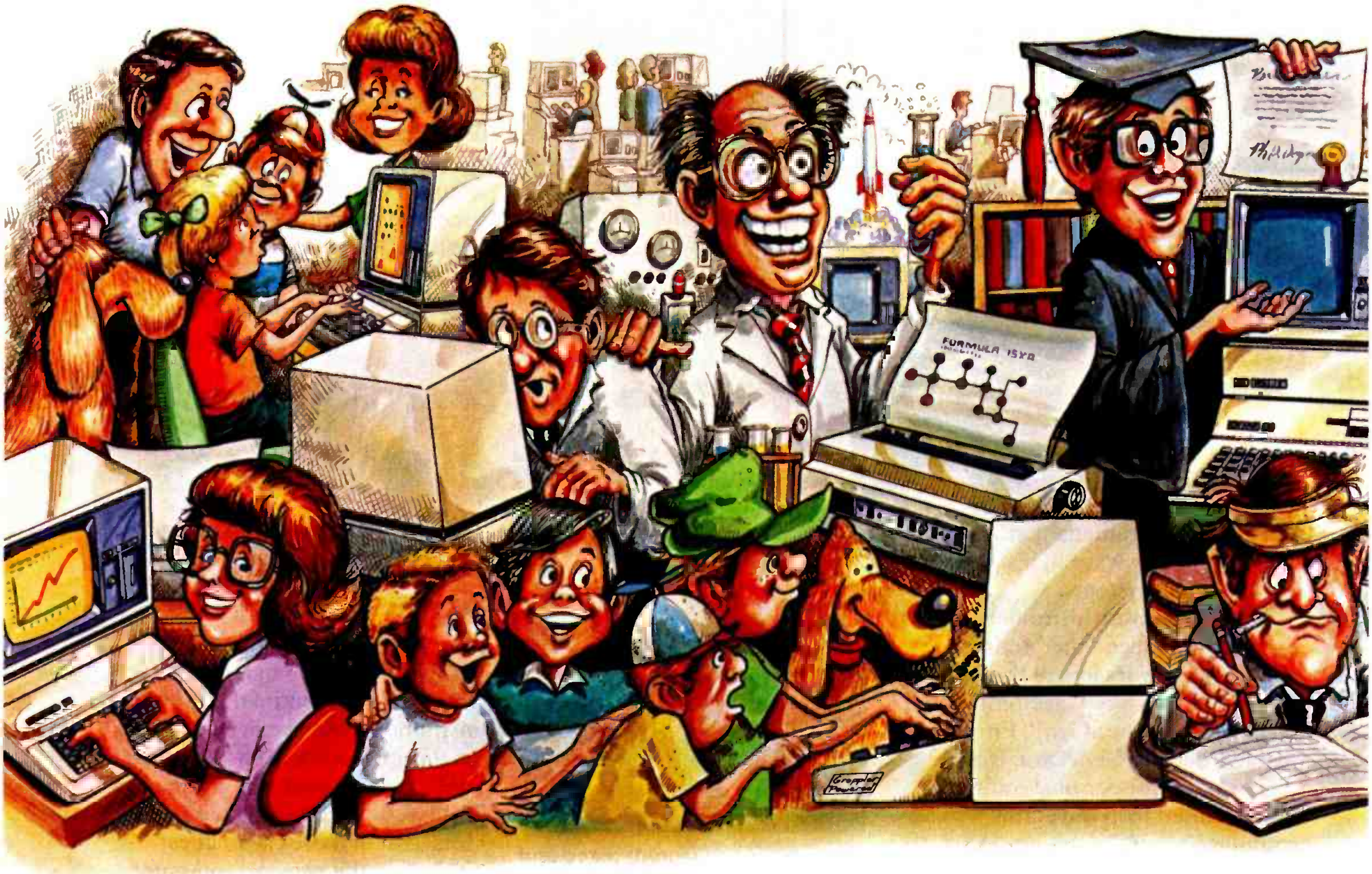

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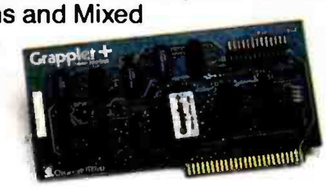

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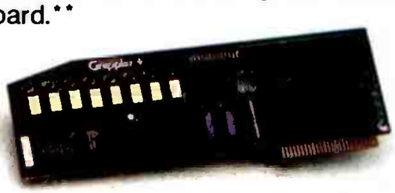

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Graphics Artistry On Line

A Telidon videotex workshop sponsored in part by the National Endowment for the Arts explores a new medium for artistic expression

by Martin Nisenholtz

The paint is an electron beam, and the canvas is a luminescent bubble of glass; 10 million people can own an original when artists use a new graphic medium—videotex.

When the staff of New York University's Alternate Media Center began to create broadcast teletext pages with the Norpak Telidon terminal (see the text box on page 106), very little work had been done with alphageometric graphics in areas where we felt they could be quite effective. We wanted to try using the graphics to enhance the legibility of text; to create maps, charts, diagrams, and other symbolic representations; and to improve the overall aesthetic appeal of a teletext or videotex service. We also hoped to define the stylistic limitations of the medium, both in content and design. At that time, mid-1979, few artists had worked on Telidon production terminals and the field showed little creative diversity. Although several commercial field trials were in the planning stages, we wanted to involve more creative people in the very early stages of the medium. Therefore, in addition to our work with teletext, we decided to develop a noncommercial videotex database to explore the more complex database architecture of the two-way videotex system.

On April 1, 1981, the National Endowment for the Arts (NEA) began funding an artists' videotex workshop. Artists would be invited to learn to use the Norpak equipment and to create works that would be structured into a hierarchical database for display over videotex systems in the United States and Cana-

Photo 1: *The opening page from "Nancy Reagan Takes the Subway," an interactive comic strip by Maria Manhattan.*

Photo 2: *A page from "Snap Shots" by Mary Beams. Note use of textures.*

da. This independent production facility began its work with three major goals:

Creative growth: Working under the production constraints of a fast moving videotex or teletext operation, it's difficult to set aside time simply to explore the medium. However, a certain amount of "waste" is built into an exploratory program, and in this more relaxed environment ideas tend to emerge that can then be integrated into an operational setting. In many fields commercial applications spring from ideas that are spawned in laboratories established by artists and engineers. The computer graphics field serves as an excellent example, in which conceptual thinking and experimentation often lead to new commercial applications and vice versa. The first goal of our videotex workshop was to be the basis for such experimentation.

Content diversity: Creative growth and content diversity are related goals. A wide assortment of artists with different backgrounds and skills can best provide the intellectual richness and range of opinions necessary for growth in a new medium. And because new ideas are often stumbled upon unexpectedly, our second goal was to create an environment where people would feel free to explore their own insights.

Independent expression: The extent to which the public should be able to contribute ideas to a public videotex system is only now being addressed. While open videotex systems are more responsive and more diverse than closed systems, the British experience suggests that too much diversity can result in confusing and illegible pages, nonstandard routing commands, and content that is redundant and sometimes crude. Our third goal was to establish a framework for independent thought and expression while maintaining database consistency and page legibility.

The Process

Bringing this rhetoric down to earth meant first exploring the visual characteristics of the alphageometric presentation standard and then structuring the discrete videotex frames in a usable, public videotex database. We invited different types of artists—illustrators, animators, journalists, and conceptual artists—to ensure that a diversity of skills and points of view would be established.

Photo 3: *A page from Wendy Richmond's "Cultural Patterns."*

Ten artists were selected to learn to use the Norpak Telidon terminal. Only one of these artists had any previous experience with computer graphics.

Learning Curves

How long does it take an artist to achieve proficiency on the production terminal? That depends on the demands of the production operation, the need for complex graphics, and the personality and skill of the artist. Most of our workshop participants were creating complex graphics after three or four sessions on the terminal. However, some of these artists may not have been capable of creating production-quality pages until their third or fourth month, if ever (see reference 1).

Database Structure

While learning the basic commands of the Norpak software and achieving skill in using geometric primitives to create images (see the text box on page 108), the artists also had to learn the context in which these discrete frames were being placed. That is, they had to learn to structure their own databases to be incorporated into a larger project database and, more globally, into the databases of several system operators. Some artists responded by building sequential series of pages, such as Maria Manhattan's "Nancy Reagan Takes the Subway," a sequential cartoon (see photo 1). To display the next page in the sequence you simply press the forward arrow on the keypad. Other artists, responding to the numerical choices offered by the Norpak keypad, built more complex databases in which more than one choice is offered throughout. Mary Beams' "Snap Shots" (see photo 2) is a series of short stories that are selected from a subindex. Beams used a house with different rooms as a metaphor for the database architecture.

For the overall NEA database, we were far more concerned with diversity of content and style (see photo 3) than with achieving a consistent graphics presentation style across artists' databases. Nonetheless, we needed standard application-level commands for each videotex system on which the work was shown. This entailed specifying user commands in the bottom right-hand corner of each page, constructing an index page for the overall database, and making sure that each artist's database conformed to the tree structure indexing and routing schemes for each system.

Graphics Capabilities and Trade-offs

The Norpak software generates six colors and six shades of gray, as well as black-and-white images. However, laying different fill patterns in different colors on top of one another gives an image a heightened look of texture. We found two major trade-offs in using such textures. First, a textured pattern displays much more slowly than a solid or outlined shape because a textured fill pattern writes in more memory locations than a solid or outlined shape. Thus, when the textured geometric shape redisplays, it takes longer to recall from memory. Second, finding the "right" textured pattern may take hours of experimentation with different fill patterns, pixel densities, and line attributes. Because of these limitations, we feel textured patterns should be used selectively and over small areas of the screen.

Animation

In some instances, animation can add visual appeal and excitement to a videotex image. In other cases, it can be distracting, tiresome, and wasteful of memory. Using the Norpak IPS-2E software, the artist animates an image

The First Step: Broadcast Teletext

In 1979, the Alternate Media Center of New York University's Tisch School of the Arts conducted a planning study of broadcast teletext for the Corporation for Public Broadcasting and National Telecommunications and Information Administration (see reference 3). The following year, the center proposed a field trial of teletext in association with public station WETA-TV in Washington, D C. The field trial was jointly funded by the Corporation for Public Broadcasting, the National Science Foundation, the National Telecommunications and Information Administration, and the Department of Education. The Canadian Telidon system was selected for production of teletext pages, which were transmitted over the vertical blanking interval (VBI) of by copying it in the background color and then again in another screen position in the original or some new color. When the page displays, the image appears, disappears, and then reappears in the new position, conveying the illusion of motion. New software developments allow the artist to manipulate the blink function by specifying time intervals between blinking images, which may change color. Although the expanded blink function improves the animation capability, artists should be aware that its overuse will distract viewers. We found that animation succeeded most when it added meaning to the frame and wasn't purely decorative.

Legibility

A delicate relationship exists between the amount of text placed on the screen and its legibility. Several artists worked to arrive at what they felt was a balanced format for text preparation. They improved clarity and legibility by avoiding long sentences and by dividing the frame into three or four separate paragraphs, each with one or two shorter sentences. They found that a light gray text against a dark gray background was a legible combination and that, in general, lighter backgrounds were too harsh on the eyes (reference 2).

the television station's signal (see reference 4). On June 24, 1981, a test group involving 40 homes and 10 public locations began receiving teletext daily, from 8:00 A.M. until 12:00 midnight. The teletext service was designed and operated by Alternate Media Center staff at WETA in Shirlington, Virginia. A research team evaluated users' responses to different categories of content, editorial styles, page designs, indexing schemes, and related issues. The field trial was concluded on August 30, 1982, and the broadcast station has since adopted the service as part of its overall broadcast operation. Results of the field trial are available to the public from the Alternate Media Center, 725 Broadway, New York, NY 10003.

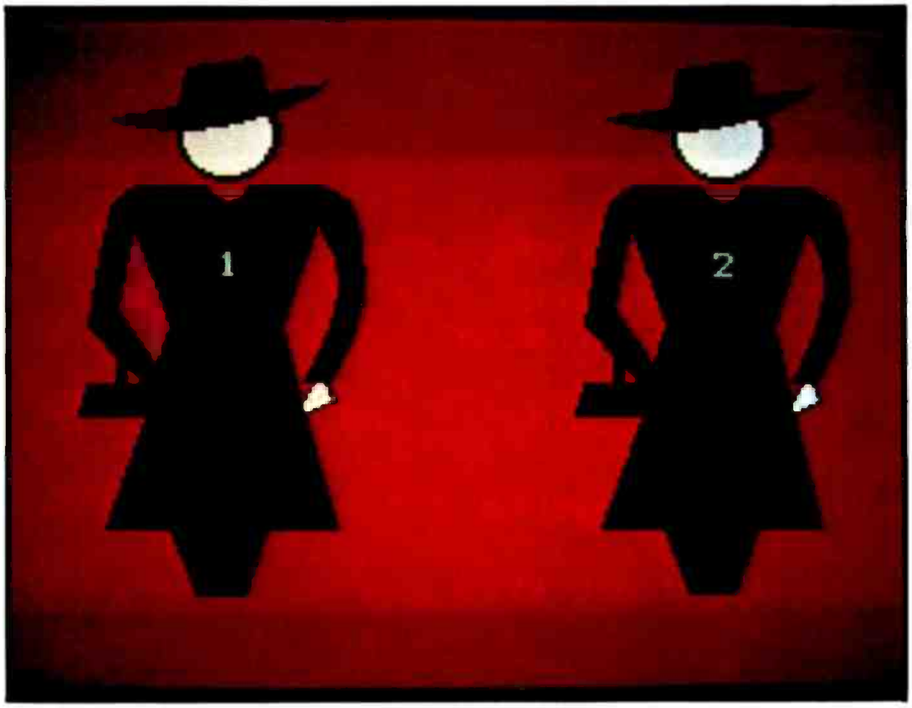

Photo 4: *A pictogram game developed by Martin Nisenholtz, called "Mystery of the Drink."*

Database Attributes

We discovered serious economic trade-offs in balancing database sophistication against usage costs. In many instances, however, the more sophisticated search procedures are easier to use and add features to videotex that are unavailable on more traditional databases. For example, at least one major videotex system is experimenting with multifield key-word search procedures. You needn't search through a cumbersome tree structure for restaurant information. Instead, you enter the desired type of restaurant and other dining attributes (e.g., price and location), and the computer finds the appropriate restaurant. These advanced database features were not available to us, but they will have an impact on future planning. At the outset of the workshop project, our concern was to build a small hierarchical database (approximately 250 pages), compatible with early videotex systems. Therefore, we didn't encounter the complex problems of constructing a large hierarchical database. Nonetheless, we experimented with two features to make the database more attractive and fluid: overlays and indexing symbols.

By default, all Telidon pages coming over the consumer's terminal clear the screen to black before delivering the next page. One useful characteristic of the picture editor filing system is the ability to overlay new text or graphics on a portion of the previously drawn page. This improves display time and continuity over related frames of content. This feature is particularly handy when presenting changing textual material against some fixed graphic display and was used widely by our artists in storytelling.

Artists were also encouraged to help users negotiate the tree-structure indexing scheme with visual cues. For example, maps were used to replace words in leading users to information on different geographical locations. A game was developed that used pictograms rather than textual descriptions to lead users from one database location to another (see photo 4).

Results

The final product of the National Endowment for the Arts videotex workshop was a roughly structured electronic magazine with the works of 10 artists contained in 425 pages, including index pages (see photo 5),

Photo 5: *The contents page from NEA videotex magazine.*

works in progress, and a section on gallery listings and information for the Los Angeles show mentioned below. Thus far, the NEA workshop material has been shown at the American Film Institute's National Video Festivals in Los Angeles and Washington, DC, and was transmitted for three weeks over the Times Mirror Videotex Service. At this writing, it is being loaded on the Sask Tel videotex system of Saskatchewan Telecommunications.

New Directions

In addition to the basic ideas of artistic expression, diversity of content, and design research, other elements could be integrated into a videotex workshop:

Increased communication: By using the messaging facilities now available on most experimental videotex systems, interaction can take place among artists with videotex-compatible microcomputers and between these artists and other videotex users. Ongoing computer conferences could develop where artists might take primary responsibility for the overall direction of the interaction, but where videotex users could also input questions and opinions on the system. In turn, this could lead into the area of pictorial telecommunications. New types of stories may also emerge, in which writers develop an ongoing plot and selected users play roles in its development—a type of computer-based soap opera. Increased communication among artists means that new visual symbols could be exchanged to form the basis of a more complete understanding of visual literacy.

New types of stories may also emerge, in which writers develop an ongoing plot and selected users play roles in its development—a type of computer-based soap opera.

Information on arts events: Although the information component of the NEA workshop was very limited, it generated a great deal of enthusiasm from members of arts organizations who wanted to have their events, schedules, and general information put into the videotex system. A more comprehensive database might include organizations that would regularly enter and update material into a videotex magazine. Over time, organizations with compatible microcomputers could update their own material. The end product would be a comprehensive arts information service. For example, if you were interested in seeing Edward Weston photographs in galleries in New York, you would enter this information, and the videotex system would provide an answer in the form of a schedule of exhibits.

Marketing applications: Arts orga-

The Telidon System

The videotex production equipment used at the Alternate Media Center is part of Telidon, a Canadian system used for both videotex and teletext. Telidon allows the operator to specify the screen locations of seven geometric primitives by defining the picture description instructions (PDIs) for each shape. These include the following:

Dot: *Draw a dot in a specific pixel location.*
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Rectangle: *Draw a rectangle by selecting two diagonally opposite corners.*
Arc: *Join any three dots with a curved line.*
Circle: *Draw a circle by specifying two points defining the diameter.*
Polygon: *Join any number of dots with lines.*
Text: *Select size and height of characters.*

The designer selects shape attributes such as colors, fill patterns, pixel densities, and line characteristics (e.g., dashed, dotted). By ordering and overlapping these graphics elements, images are created.

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nizations and individual artists often wish to distribute printed brochures, catalogs, and events schedules to specific groups or individuals. Video artists may wish to sell their cassettes to owners of video-cassette recorders. Gallery owners may wish to expand their mailing lists to include a broader range of collectors. Artists who design crafts, clothing, or jewelry may wish to reach new customers through videotex. Local arts-supply stores, photographers, and others providing arts services may wish to advertise on a videotex directory. Future videotex databases might address these needs of the arts community. Such services could have broad commercial applications.

Telesoftware: Future videotex design workshops may combine the skills of computer programmers, artists, and writers to experiment with designing educational software in art history and appreciation, language training, and new types of computer games. The transmission of a computer program from a host to a remote terminal demands more memory than most existing videotex terminals have.

Conclusions

In the United States, videotex systems are developing within commercial settings that are far more discriminating in the videotex material and services they accept than are common carriers such as the Prestel system. Nevertheless, within these new systems there is an enthusiasm about learning and an acceptance of new ideas that, for the most part, seem compatible with the goals set out by the NEA workshop program. New design workshops should continue this experimentation and development and, in the process, help blaze the trail for videotex in the United States. ■

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About the Author

Martin Nisenholtz is currently affiliated with Olgilvy and Mather Advertising (2 East 48th St., New York, NY 10017). At the time the article was written, he was project director for the Alternate Media Center of New York University's Tisch School of the Arts.

Author's Note: *The views expressed in this article are those of the author and do not necessarily reflect the views or policies of the National Endowment for the Arts or New York University.*

The current project director of the NEA workshop, Pat Quarles, can be reached at the Alternate Media Center, New York University School of the Arts, 725 Broadway, New York, NY 10003.

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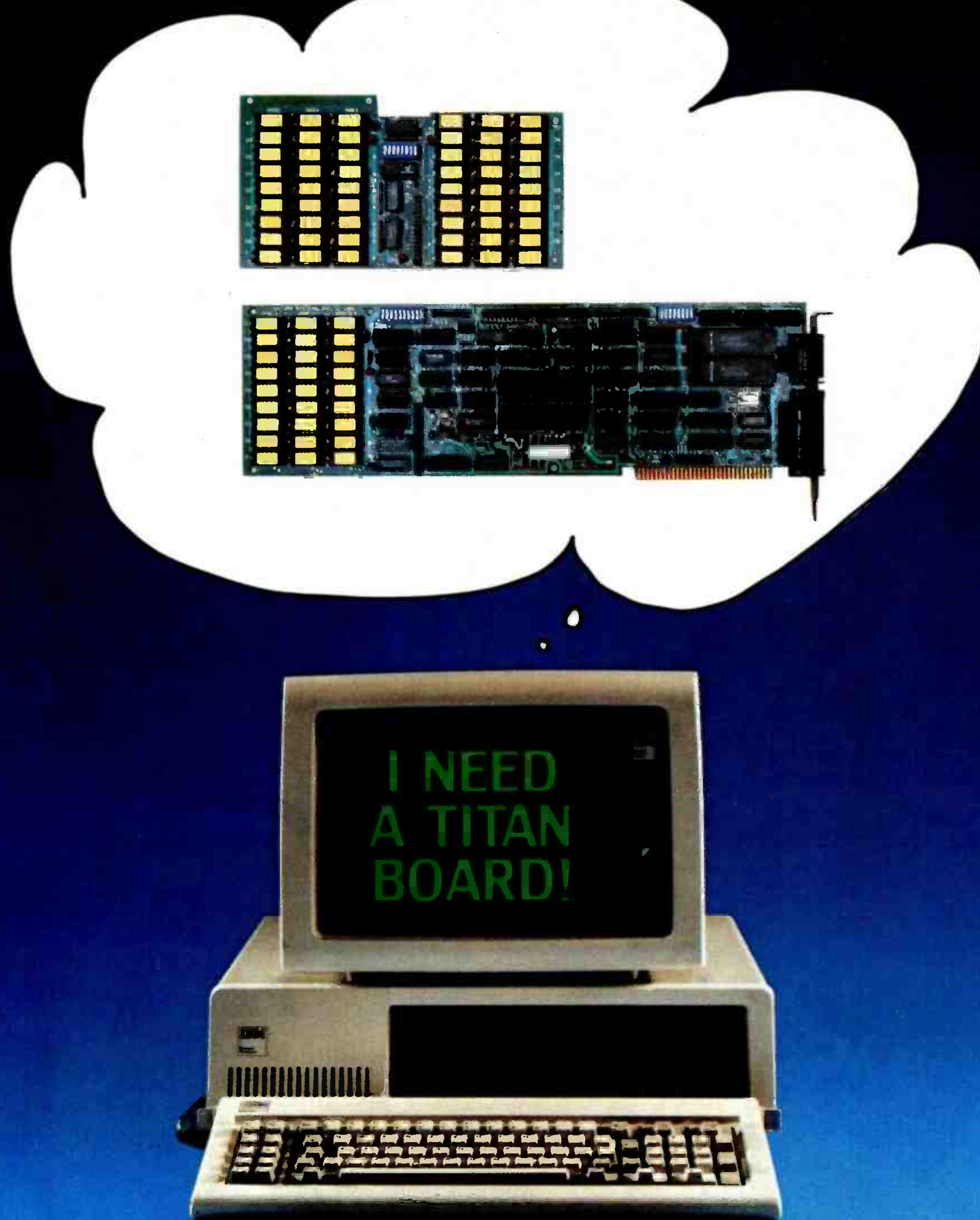

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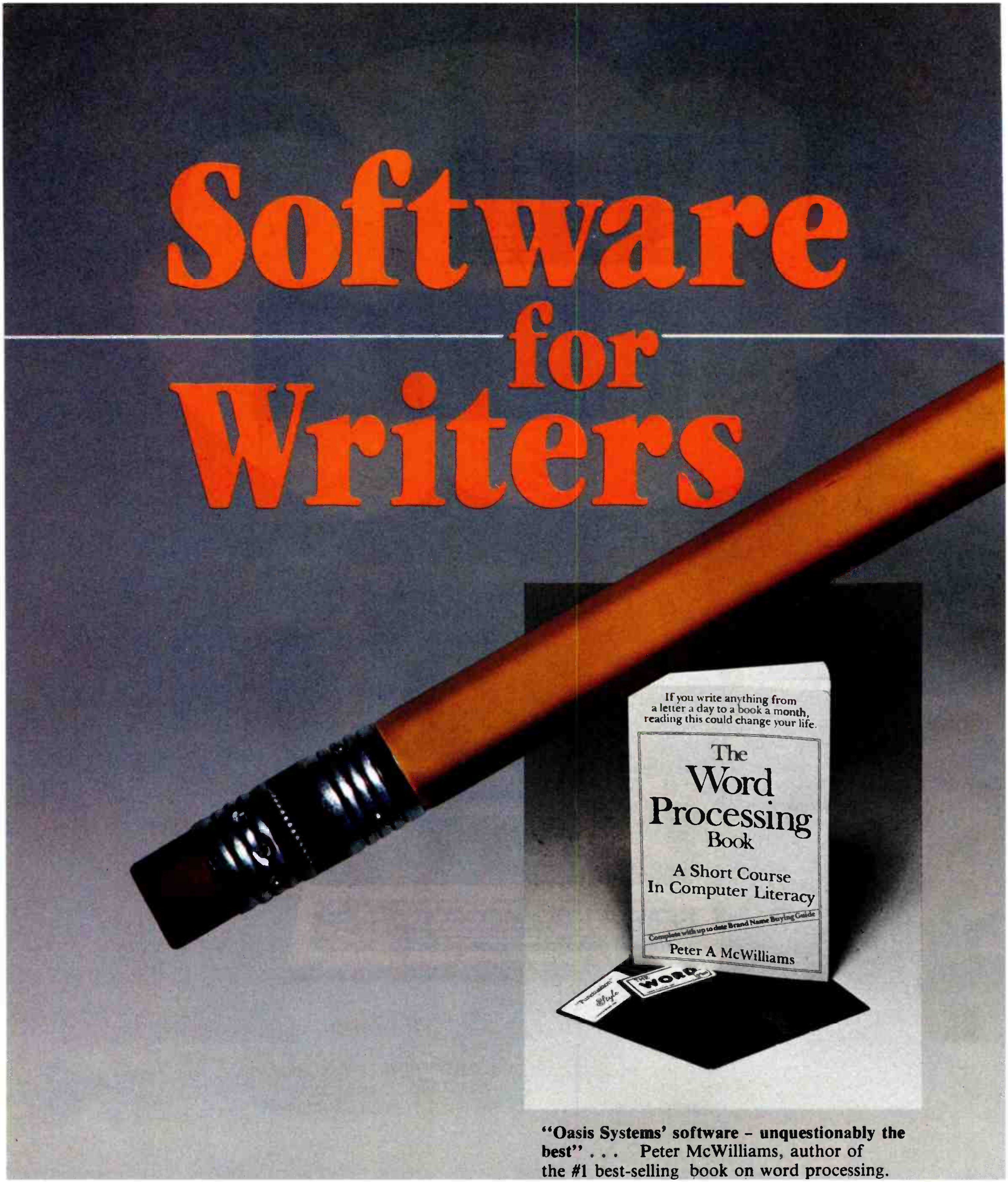
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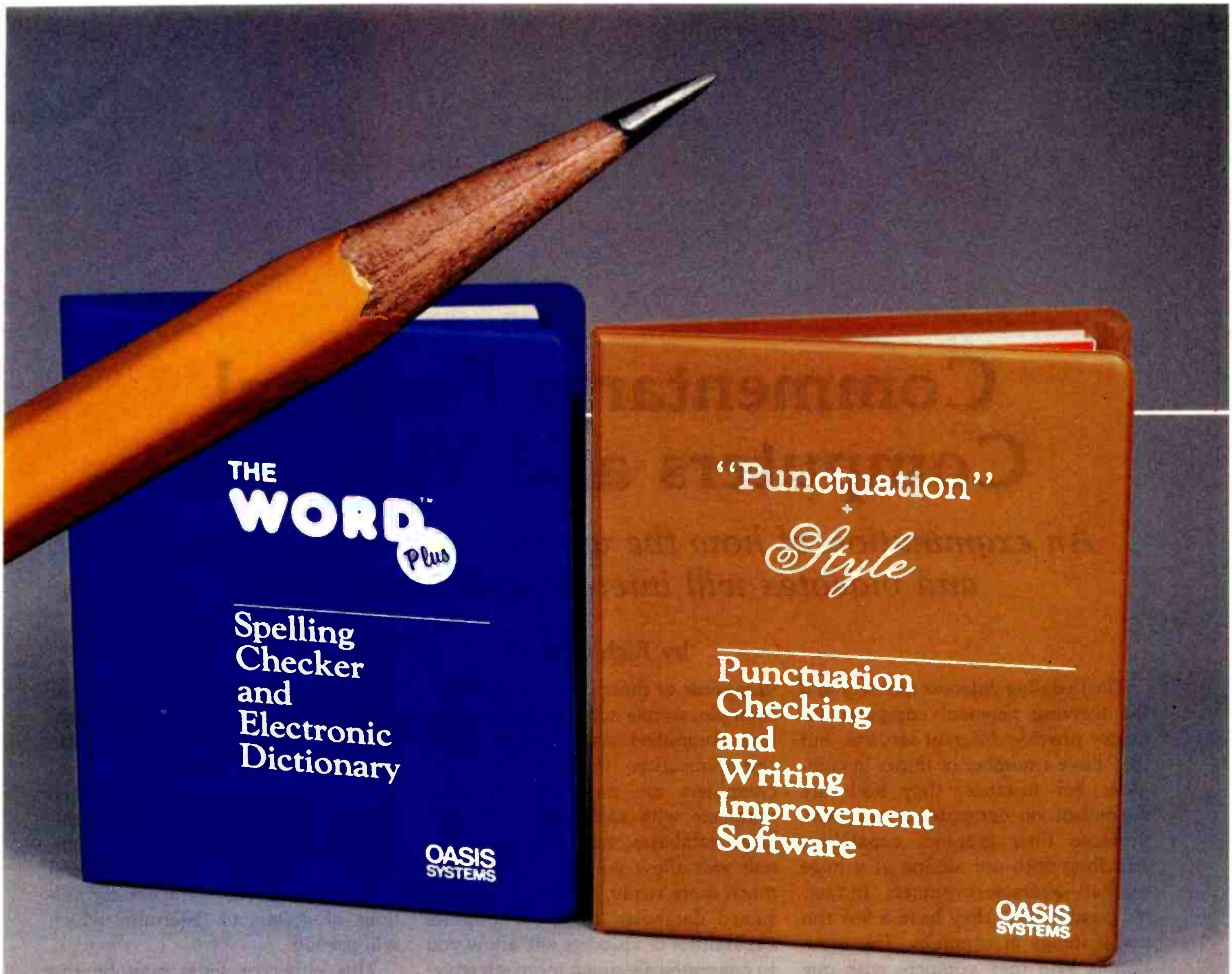

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Commentary: Personal Computers and Videotex

An examination of how the worlds of personal computers and videotex will interact with one another

by Rich Malloy

The fledgling videotex industry and the thriving personal computer industry provide different services, but they have a number of things in common. For instance, they both are dependent on computers, they both promote their graphics capability, and they both are aiming at a huge market—average consumers. In fact, it's possible that they have a few too many things in common. The question is Will they compete with one another or complement each other?

We are already familiar with the services that can be provided by a personal computer. A videotex terminal, however, will be able to provide some of those same services (for example, simple computations on the host computer) along with excellent communication facilities. Personal computers are now able to communicate with each other and with large databases, but videotex terminals will allow you to communicate much more easily, thanks to well-designed databases. And the graphics capabilities of videotex will allow you to communicate much more effectively—not just in words, but in images and icons (the effectiveness of which has been shown by systems such as Apple's Lisa).

Although the capabilities of these two machines, the computer and the terminal, are somewhat different, they are designed for the same place: the top of a desk. And because we all have limited desk space and limited budgets, we may be faced with a difficult choice: to buy a personal computer or a videotex terminal. Several large corporations are spending millions of dollars to determine which will prevail.

This either/or view may be too simplistic, however. It is quite probable that, although videotex and personal computers may compete with one another to some extent, they will more likely enhance each other's ca-

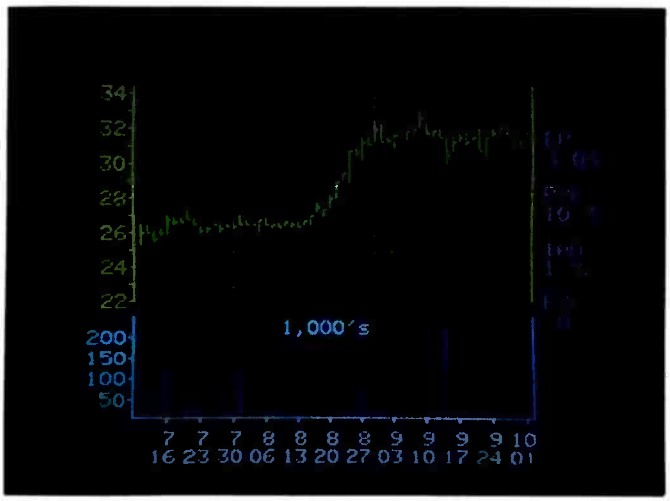

Photo 1: *Two examples of videotex pictures that will be available on Compuserve if you have a NAPLPS decoder.*

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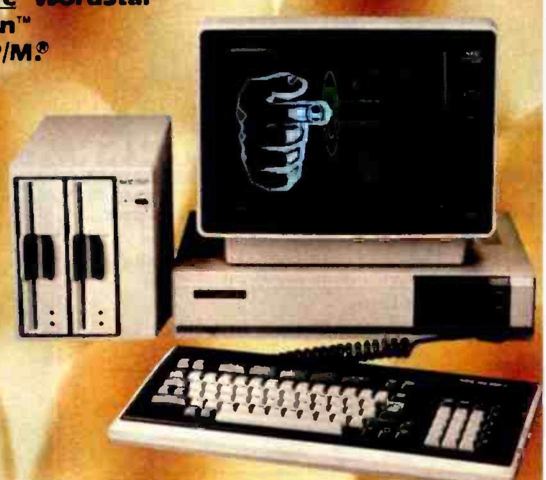

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pabilities and, in the long run, may merge to become different facets of the same general product.

Already we are seeing products that allow personal computers to act as videotex terminals, and videotex terminals are being designed with several features taken from personal computers. At least one product on the market can be equally well described as a personal computer or a videotex terminal.

History

Videotex and personal computers both developed as a means to give the average person access to the power of a computer. When videotex was first conceived in Britain during the early 1970s, personal computers were nonexistent, a fact that forced designers to develop a system of dedicated terminals connected to a large central computer. Because dedicated terminals would be too expensive, the early developers decided to modify the consumer's home television into a terminal. And to make the service as palatable to the masses as possible, heavy emphasis would be placed on ease of use. This meant that the system should have good graphics capabilities because a picture is much easier to read than a page of text.

The first Prestel terminals consisted of a decoder box placed on top of a home television and a small numeric keypad and were fairly simple. They performed a minimal amount of processing of data before displaying it on the screen.

As videotex technology became more advanced, the terminals had to become more complex. A terminal using the North American Presentation Level Protocol Syntax (NAPLPS) has to be capable of performing a significant amount of processing. It must be able to draw lines, fill in polygons, display newly defined characters, and even perform simplistic animation.

Meanwhile, out in a garage in California—and dozens of other places—people were trying to bring computer power to the masses in another way, by simply shrinking the computer to a suitable size and simplicity. The result, of course, was the personal computer.

Like videotex systems, personal computers have also undergone several changes. The first microcomputers had very crude graphics capabilities, but as time went on, graphics became more and more desirable, and thus more prominent as a feature. The result is that the graphics capabilities of some home computers are beginning to approach those of videotex systems.

Applications

Videotex and personal computers have rather different applications. Personal computers are most efficient for data-processing tasks that require a large amount of user interaction (for example, a spreadsheet calculator or a word processor). Personal computers can also communicate with other computers, but this capability is limited by a shortage of easy-to-use communications software and the lack of a graphics standard for sending graphics from one computer to another.

Videotex systems, on the other hand, are very good at communicating. Videotex employs a simple menu structure that makes it easy to use, and each system has its own standard graphics protocol that can be decoded on any terminal in the system. The general consumer can use videotex to retrieve news, shop at home, make banking transactions, and send electronic greeting cards to other videotex users. The graphics capabilities of videotex will be attractive to advertisers, who will help defray the cost of the system.

Business people can use videotex to retrieve quickly changing, specialized information, such as stock prices or the location of ships at sea. It can also be used for electronic mail. Salespeople can use private videotex systems to check inventories or to learn about new products. In the United Kingdom, Prestel is used by car dealers to locate cars that conform exactly to their customers' preferences.

Note that many business applications of videotex are not heavily dependent on graphics and thus might be performed by personal computer networks if an easy-to-use

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database management program were available. Also, videotex is somewhat inefficient for data-processing tasks, such as word processing, which require a large amount of user interaction.

Marketplace

People in the personal computer business tend to envision a huge potential market. We frequently hear about a computer on every desk or even in every home.

Videotex industry people envision a market of similar proportions. After all, almost every house in the U.S. has a television set, and the great majority have phones. Thus, a tremendous number of people already have, as it were, two-thirds of a videotex terminal. And, in terms of applications, a large number of people read newspapers, shop by mail, use electronic banking machines, and send express mail, all of which can be done by a videotex system. Particularly appealing to videotex supporters is the fact that television, during its formative period, took only six years to saturate 75 percent of the American market.

The current situation, however, is that both personal computers and videotex are rather expensive. For the near future, their markets consist of business people and affluent consumers, and their applications are somewhat business-oriented. Today, two of the most prominent applications of videotex are the fast retrieval of quickly changing, specialized information (such as gold prices) and electronic mail. And videotex may take a long time to become established. While television was very quickly adopted, another important product—the telephone—required more than 70 years to reach even half the homes in the country.

Today many companies, including IBM and Honeywell, are aiming their videotex efforts only at business customers. These companies are promoting small private systems that will allow, for example, salespeople to quickly check inventory and new product information. Prestel, the largest true videotex system, has found that over 80 percent of its decoders reside in places of business.

This concentration on the business market is typical also of many personal computer manufacturers. But while this market is large and capable of absorbing high-priced machinery, the huge consumer market lies ever in the distance, and even a business-oriented company such as IBM is rumored to be preparing a consumer-oriented home computer.

Because there is a finite amount of desk space in the average office, videotex and personal computers may soon be going neck and neck for the business market and may later battle again for the home market.

A Merging

Instead of fighting for the same markets with pretty much the same technology, videotex and personal computers will probably share features and merge into one powerful product. Personal computers are beginning to adopt the graphics features of videotex. Meanwhile, videotex terminals are starting to

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feature capabilities such as information storage and printout that have been borrowed from the computer market.

Personal Computers as Videotex Terminals

True videotex systems differ from conventional timesharing systems primarily because of their extensive graphics capabilities. For years *nongraphics* timesharing systems have been available for personal computers. These systems, which here we shall call videotex-like systems, include services such as The Source, Compuserve, and Dow Jones News/Retrieval.

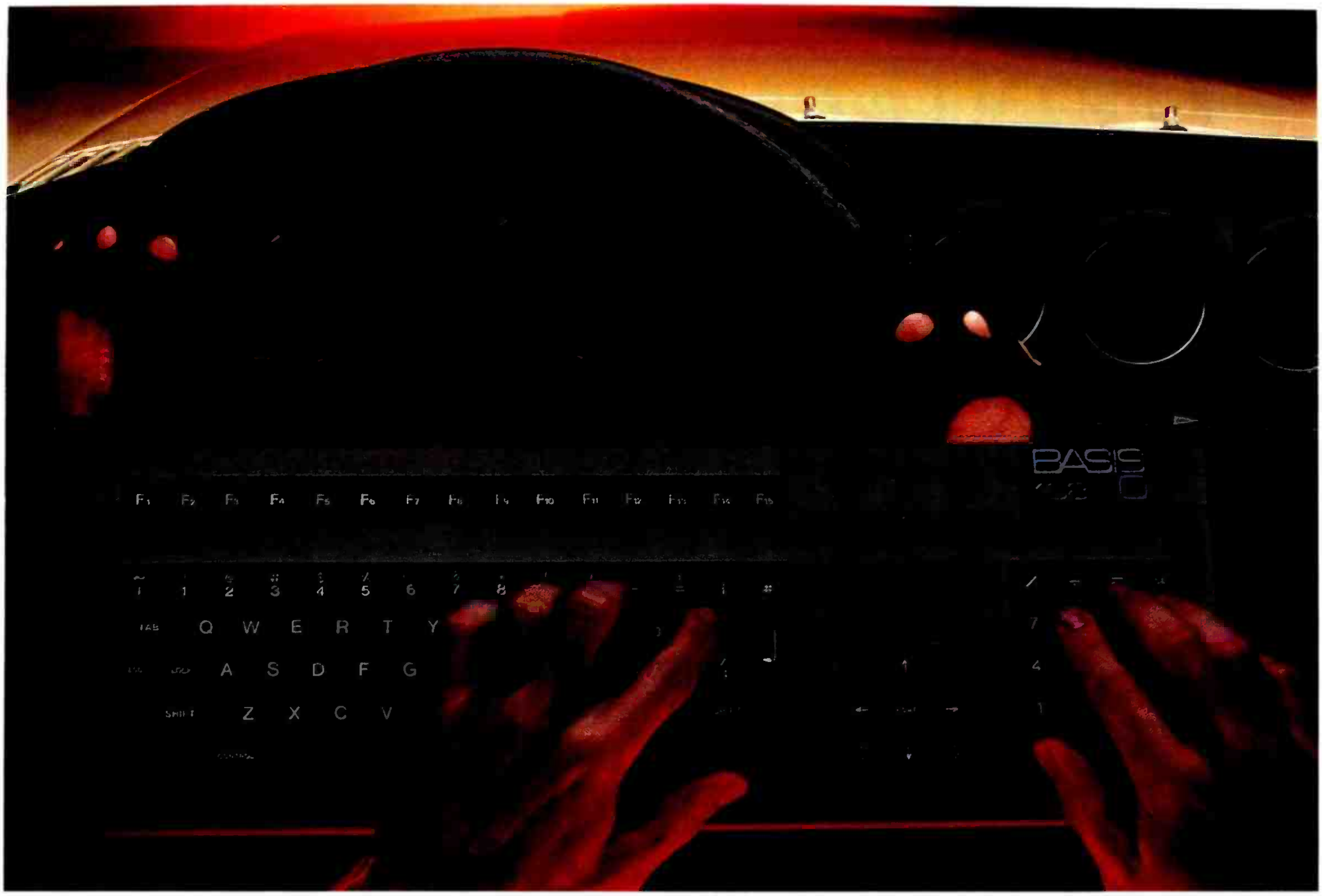
Compuserve features a number of large databases and some communications features, such as electronic mail and even a CB-radio emulator. The Source has similar capabilities and features a sophisticated computer-moderated conferencing system. Dow Jones News/Retrieval features stories from *The Wall Street Journal*, stock prices, and an encyclopedia but offers no electronic mail capabilities.

Besides their lack of graphics, these services fall somewhat short on another vital videotex element: ease of use. Over time these services will probably develop easier protocols. In the meantime, new services such as Delphi from General Videotex Corporation (377 Putnam Ave., Cambridge, MA 02139) hope to provide a similar service in a more friendly way.

The other lacking element, graphics, should be available very soon. Compuserve, according to Richard A. Baker, editorial director, already has some stock-price information encoded in NAPLPS on its system. Apparently, if you have a NAPLPS decoder you can retrieve a graph of the price of your favorite stock (see photo 1). The problem is that very few people have decoders to display these pages. And here we enter the familiar chicken/egg question: Which has to come first, a lot of decoders or a lot of databases? When videotex decoders become more prevalent, all of these services will probably add videotex pages.

Prestel and Personal Computers

The British videotex service called Prestel was the first and so far most successful videotex system in the world. It currently has about 20,000 subscribers. Prestel World Service has been available for microcomputer users in the U.S. for about two years now. Until recently a company called Logica in New York City sold programs that would allow some microcomputers to decode Prestel pages. For example, Appletel was available for the Apple II ($85), and a similar program was offered for the TRS-80 Model III ($50). Unfortunately the graphics could be displayed only in black and white. Logica also sold time on the Prestel system itself, but this service was rather expensive (a minimum of $50 per month) and was of somewhat limited interest to most American business people because nearly all of Prestel's information is



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related to the United Kingdom.

Two months ago, the U.S. branch of Torch Computers (61 Commerce Way, Woburn, MA 01801) became the exclusive distributor of Prestel World Service in this country and began selling the Prestel service and the Prestel-decoding software at a lower price. Torch also has tentative plans to establish a Prestel database on this side of the Atlantic, which would be oriented toward American information.

Prestel is actually a sideline for Torch. The company's main purpose is to sell the Torch Computer. This rather hefty Z80-based machine includes a 6502 coprocessor and comes complete with two floppy-disk drives, 96K bytes of memory, an RGB (red, green, blue) monitor, and a bundle of software. The price for all of this is about $4995. Included in the bundle of software, by the way, is a Prestel decoder that can display all eight of Prestel's vivid colors.

For those people who would like to display Prestel pages on an IBM Personal Computer, a company named Wolfdata (187 Billerica Rd., Chelmsford, MA 01854) will provide several products of interest. One of these is a color interface card that plugs into the PC's expansion bus ($600). Different software products can then turn the PC into a Prestel terminal ($250), a frame-creation terminal ($450), or even a small host system ($500). Thus a complete, though small, Prestel system could be set up using only IBM PCs.

A year ago, IBM announced that it would support the Prestel coding format for its videotex products. Although IBM's main product in this area is a database program for its Series/1 minicomputer, the company relies heavily on Wolfdata's products for its demonstrations of videotex.

While I'm on the subject of Prestel, I must make mention of the BBC computer from Acorn Computers in the U.K. (see Gregg Williams' "Microcomputing, British Style," January, page 40). This computer may not be marketed too heavily in the U.S., but one of its features is the ability to decode Prestel. If the BBC computer becomes very popular in

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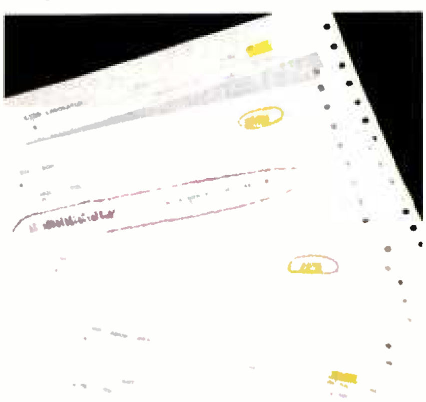

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the U.K., Prestel may gain a significantly larger subscriber base.

NAPLPs and Personal Computers

The NAPLPS protocol, which is a standardized version of AT&T's PLP (Presentation Level Protocol) system, has such powerful graphics capabilities that many personal computers are severely limited in their ability to exploit them (see "NAPLPS Standard Graphics and the Microcomputer" by Leo Lax and Mark Olson on page 82). The decoding program takes up about 30K bytes of memory, and the minimum terminal configuration (256 by 190 pixels in 16 colors) requires about 24K bytes of bit-mapped memory for the display. Because NAPLPS is designed to be resolution-independent, however, personal computers can be used to display an approximation of the minimal display picture.

Like NAPLPS itself, most of the NAPLPS products for personal computers started in Canada. These products were originally designed for Telidon, the predecessor of NAPLPS. In Canada, NAPLPS is sometimes called "Telidon version 709" after Technical Note 709 of the Canadian Department of Communication. Many of these original Telidon products are in the process of being expanded to full NAPLPS capability.

One of the more interesting of the NAPLPS products for microcomputers is the Telidon Graphics System (TGS) board for the Apple II made by Norpak of Canada and sold by Apple ($595). This system consists of a circuit board for the Apple's expansion bus and a floppy disk of software programs that allow the Apple to act as a simple Telidon terminal and as a frame-creation terminal so that you can produce and send pictures to other Apples equipped with this board—and presumably to other Telidon boards.

Norpak is one of the leading manufacturers of Telidon terminals and in this product the firm seems to have taken a 6809 processor and its software out of a Norpak terminal and placed it on an Apple expansion board with the appropriate memory.

For the sake of a larger number of possible colors, the designers of this board had to sacrifice some of the Apple's resolution. The result is medium resolution (128 by 98 pixels in 16 colors). The pictures from this system are somewhat coarse, but interesting nonetheless (see photo 2).

Unfortunately, this system uses the pre-NAPLPS form of Telidon. The manufacturer says that the system will decode files written using the full version of NAPLPS but will display only those features that it supports. This capability is hard to test, however, because there are very few NAPLPS databases available at this time.

Another NAPLPS-based product for the Apple II is Picture Creation System—Telidon/Apple (PCS-T/A) sold by Softwords (235-560 Johnson St., Victoria, B.C., Canada V8W 3C6). This software package, which uses the Apple UCSD system and a graphics tablet, turns the Apple into a small Telidon frame-creation ter-

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AST & PCnet Future Products:
- Universal File Server
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Other AST Products
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- Etc....

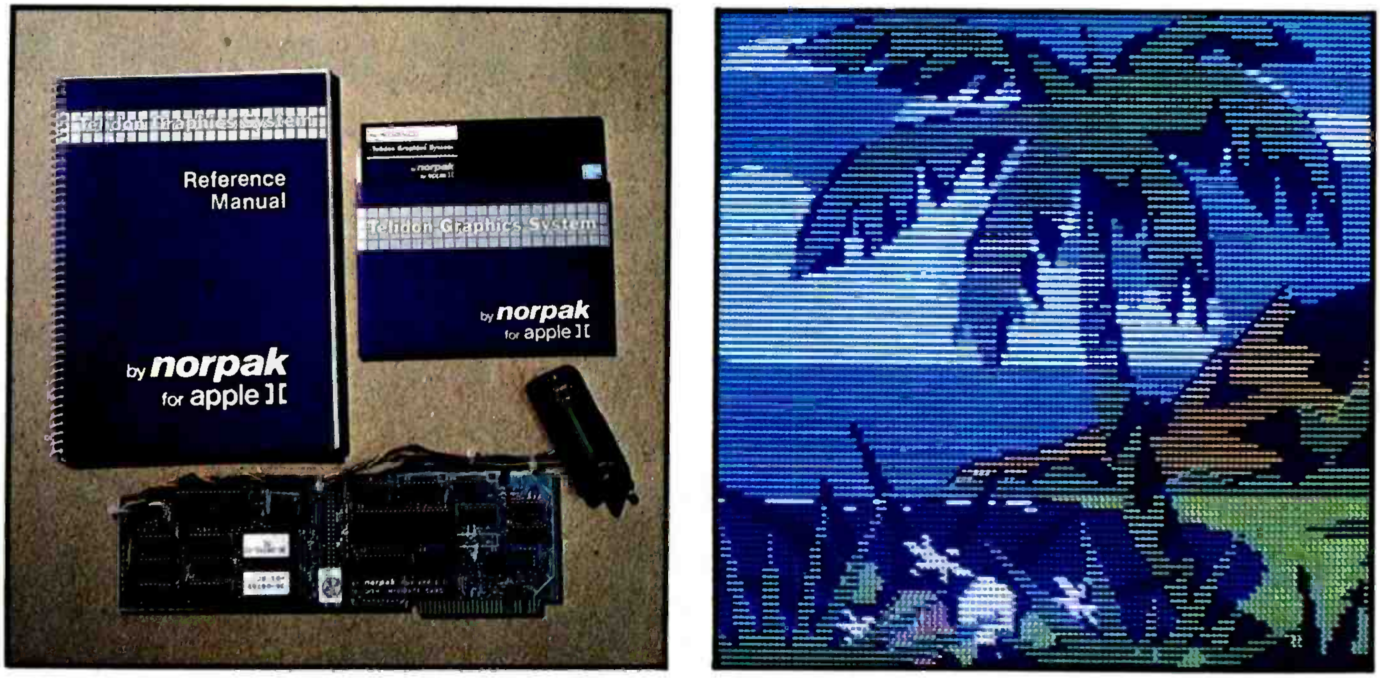

Photo 2: *The Telidon Graphics System for the Apple II and a sample display picture.*

minal. The package was originally written for the pre-NAPLPS version of Telidon, but the current version should now support full NAPLPS. The main use for this system is said to be picture creation for cable television system operators. The cost of the software is $1000.

For the IBM PC, a company called Tayson Information Technology (POB 30104, Station B, Calgary, Alberta, Canada T2M 4N7) has produced a software package (the Tayson Personal Videotex System) that will turn the PC into a complete NAPLPS-based videotex system. This package, though expensive ($2500), allows you to create pictures on the IBM, display them, and store them so that they can be accessed by another videotex terminal. This system was used fairly successfully by IBM itself at its exhibit in the Videotex '82 convention last year.

A new product called Teligraph by Microtaure (POB 6039, Station J, Ottawa, Ontario, Canada K2A 1T1) should offer similar capabilities for the IBM PC at a much reduced price ($399). Teligraph should allow you to create and store NAPLPS pictures. According to Microtaure, it will also allow you to print out a picture on the Epson printer (equipped with Graftrax) at a very high resolution. This capability will allow the IBM PC to function as a very powerful graphics system.

For the Commodore CBM 8032 and 4032, there is a package called Graph Ease by a small computer named Limicon (144 Hampton Ave., Toronto, Ontario, Canada M4K 2Z1). This package should turn the Commodore 8032 into a videotex system with capabilities similar to those of the Tayson package for the IBM PC. For $2500, Limicon says it will supply you with all you need, including a Norpak NAPLPS decoder and an RGB (red-green-blue) monitor, to turn the Commodore into a low-end computer-aided design (CAD) machine.

Several computer manufacturers should have NAPLPS-decoding software available soon. Digital Equipment Corporation (DEC) was one of the first large companies to back NAPLPS. In fact, over 70 percent of the public videotex systems in the U.S. use DEC computers (either VAX, DEC 10, or DEC 20 systems) for database management. According to Michael Mensh of DEC's Enhanced Communication department, DEC may at some point offer NAPLPS-decoding software for its new line of microcomputers, the Professional series. These computers have powerful graphics capabilities. In fact, at a videotex convention in London last October, DEC showed off a Professional 350 that was displaying NAPLPS pictures.

Torch, the previously mentioned British computer that comes complete with a Prestel-decoding software package, will soon offer NAPLPS software as well through its Canadian division.

In a significant move, Microsoft of Bellevue, Washington, has designed the new version, 2.0, of its very successful MS-DOS operating system with the capability to interface easily with several different types of programs to drive peripheral equipment. Because of this capability, it should be easy to add a NAPLPS-based interface to any MS-DOS machine. Bill Gates, the president of the company, has listed this capability among the most important features of the new version of MS-DOS. Microsoft has even hinted that it might offer a NAPLPS decoding program of its own.

Videotex Terminals as Personal Computers

Videotex terminals started out as simple devices that would display information on a home television screen and relay a user's requests

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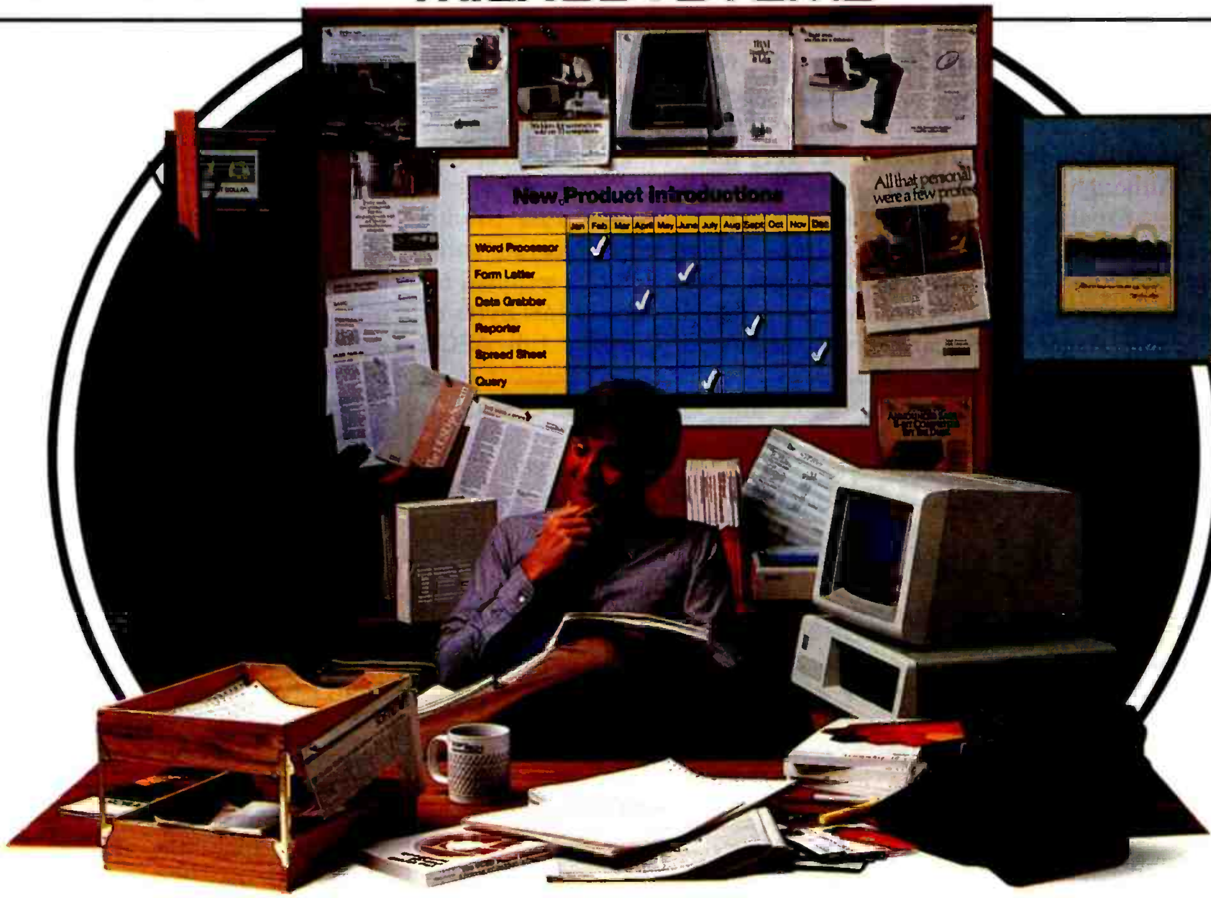

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back to a host computer. Now terminals are being developed that will interface with printers and storage devices and that will function as personal computers.

The Time Video Information Services division of Time Inc. will be using an interesting terminal for its teletext operations in Southern California. Although it is a teletext terminal (i.e., capable of one-way communication only), it will use the NAPLPS protocol and will be able to download software from the system's central computer. According to Larry Pfister, vice-president of Time Video, these terminals will have a fairly large amount of volatile memory and will be able to run simple programs (games). Matsushita, the Japanese firm that will make some of the terminals, claims that they will even be able to interface with disk drives.

A very interesting terminal is being used in Austria for videotex operations there. Called MUPID (Multipurpose Universally Programmable Intelligent Decoder), this terminal includes a Z80 processor, 64K bytes of volatile memory, and a full ASCII (American National Standard Code for Information Interchange) keyboard. Also, the terminal will rent for an incredibly low price of about $8 per month. One of the prime features of the MUPID system will be the ability to download and upload software. One of the programs that will be downloaded is a BASIC interpreter.

As videotex and teletext become more popular and as their terminals become less expensive, these terminals could become valuable peripherals for personal computer users. For example, the new videotex terminal by the Consumer Products division of American Bell (CIS Product Development, 5 Woodhollow Rd., Parsippany, NJ 07054) will sell for about $600, including a modem. If this terminal can be conveniently attached to personal computers through a serial port, this will allow even a very inexpensive home computer to display impressive graphics.

Videographic Systems of America (VSA, 520 Madison Ave., New York, NY 10022) will soon be producing a teletext terminal that will also have videotex capabilities. Personal computers can be attached to this terminal via an RS-232C connector. According to Hubert Stijns of VSA, the price of the terminal will initially be about $1000, but it could approach $250 if it can be sold in sufficient volume.

Zenith, the large consumer-oriented electronics firm, has been making terminals for a number of years. Until recently most of these terminals have been in the Prestel format, but Zenith is now producing some of the NAPLPS-based terminals for Time Video's teletext operation. Very soon, all Zenith television sets will have provisions for adding a teletext decoder right onto the main chassis.

The powerful graphics capabilities of NAPLPS offer another type of peripheral service. A Canadian company called Avcor (512 King Street East, Toronto, Ontario, Canada M5A 1M1) will produce high-resolution slides of any NAPLPS file you can send it. For example, an artist in Louisiana can design a picture on an

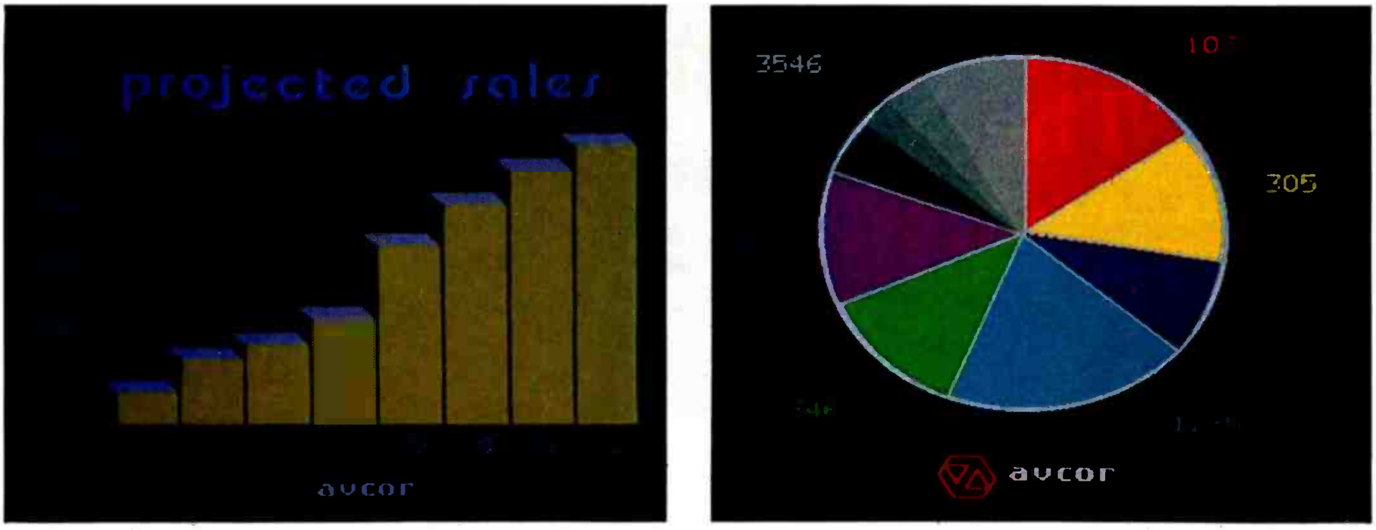


Photo 3: *Two examples of high-resolution slides (512 by 512 pixels) produced by Avcor from NAPLPS code.*

Apple computer with one of the above-mentioned NAPLPS products and then send the NAPLPS code over the phone to Avcor. Avcor will then display the picture at 512 by 512 resolution (see photo 3) and send the slide back to the artist by mail. Zal Press, marketing manager of Avcor, says that a slide will cost about $10. Company plans include opening similar facilities in the U.S., and soon slides with a resolution of 4000 by 4000 pixels will be available.

The Ideal

A combination personal computer/videotex terminal would seem to be the ideal machine. Such a machine should be possible in a few years, and it would, in effect, take advantage of the best from both worlds.

In such a system, most of the processing would be done locally. For example, word processing would be done completely on your personal machine. If you needed a certain piece of information, your system would automatically search through your personal databases. If, however, this information could not be found in your personal files, then the system would automatically become a videotex system and put you in touch with the remote database that would be most likely to have that information.

To you, the user, the point where the personal databases ended and the large remote databases began would be transparent in such an ideal system. You would simply request a piece of information, and the system would retrieve that information as inexpensively as possible. In the case of, say, spelling checking, the system would first check the words in your personal dictionary file. Any words not found in that file could then be checked in a larger, multilingual dictionary at a remote database.

Similarly, if you asked such a system what today's weather was, it might search through an index of your personal files to see if you had made any notes about the weather. If not, it would then automatically log onto an index of databases, find the appropriate database, and log onto it. There it would find a frame describing the day's weather in beautiful graphic detail.

Such an ideal system represents a great deal of work, of course. But the trend toward easy-to-use software suggests that a system like this is entirely possible. Note that in the future, users will probably not think in terms of videotex terminals or even personal computers. Users will simply see an information system, which will process, retrieve, or display any information they want, as quickly and as graphically as possible.

Conclusion

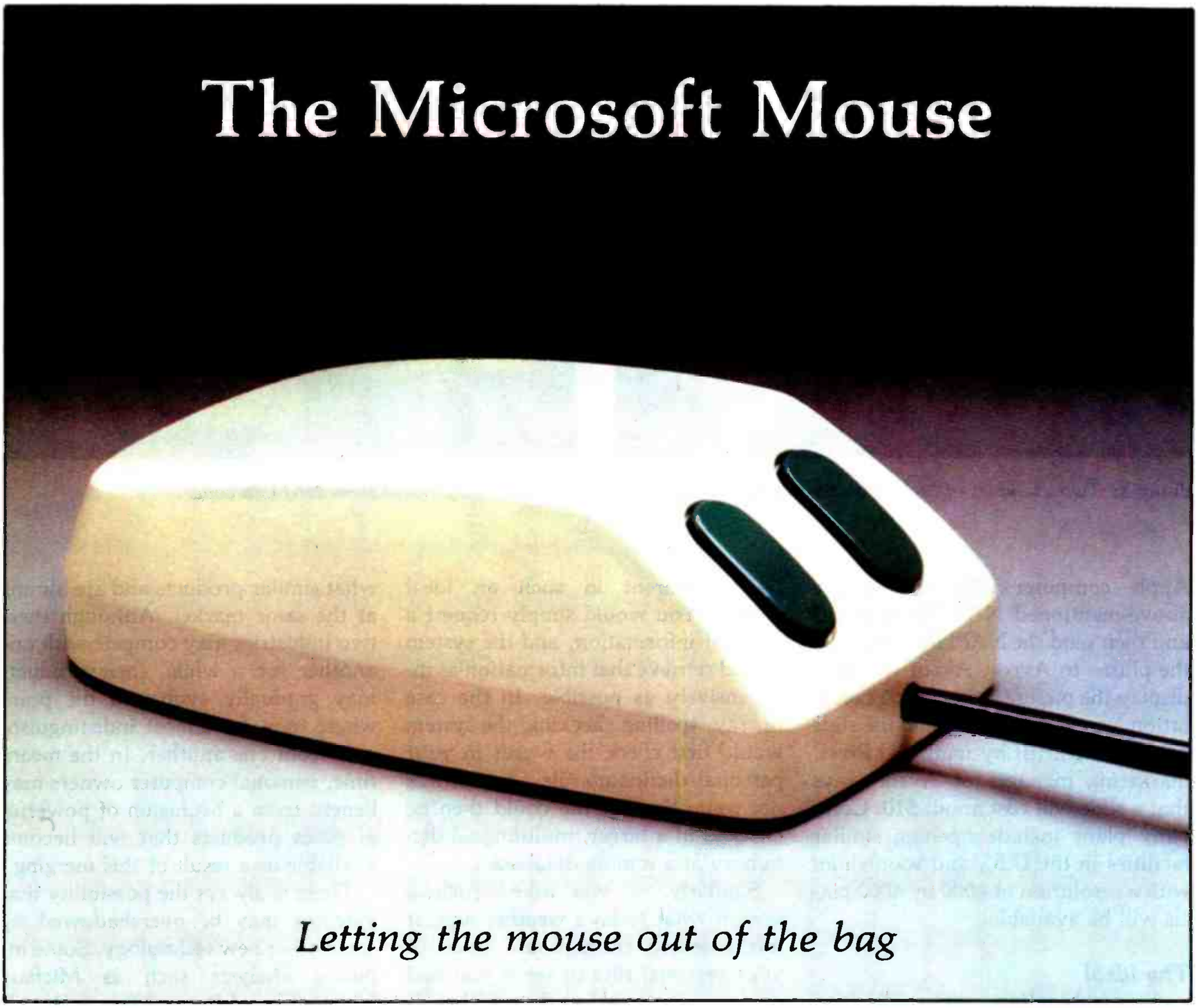
The videotex industry and the personal computer industry have somewhat similar products and are aiming at the same market. Although these two industries may compete with one another for a while, their products may gradually evolve to the point where they are almost indistinguishable from one another. In the meantime, personal computer owners may benefit from a profusion of powerful graphics products that will become available as a result of this merging.

There is always the possibility that videotex may be overshadowed by some other new technology. Some industry analysts such as Michael McLaughlin of Booz, Allen & Hamilton have suggested that videotex may be an interim technology. Eventually most of the functions of videotex will be handled by videodiscs, which will be distributed to local cable TV stations and which will display pictures of products as graphically as is now done on TV commercials. As McLaughlin says, "How can you sell a BMW on videotex if it looks indistinguishable from a Volkswagen?"

But for *fast* communication of graphics information—whether it's today's weather or an electronic Valentine's Day card—videotex should prove quite effective for some time to come. ■

About the Author
Rich Malloy is a technical editor of BYTE.

The Microsoft Mouse



Letting the mouse out of the bag

by Chris Peters

In May, Microsoft announced the introduction of its Mouse—an on-screen pointing device (see photo above) priced at $195 including mouse-based software. This relatively low-cost package is available in two versions: a plug-in board for the IBM Personal Computer (and XT) and an RS-232C-port version for any MS-DOS-based computer.

The Mouse, a hand-held input device, translates the motion of your hand to a cursor moving about the video-display screen. To use the mouse, you simply point to the area of the screen that displays your options (e.g., menu choices) and press the button(s) to choose your action. Thus, you are not required to remember confusing command sequences or even use the keyboard to input choices.

Because the Mouse rests on your desktop, it is less fatiguing and cumbersome to use than a light pen. Furthermore, it is considerably more accurate than either a light pen or a joystick. For every one-hundredth of an inch a mouse moves, a pulse is generated. Finally, you need not move your eyes from the screen, a necessity with keyboard entry.

Software

Until recently a mouse was relatively expensive—around $400, without the necessary software drivers. A mouse has also been difficult to integrate with application software because it requires a cursor to be displayed on the video display. The routine that draws the cursor must be called whenever the mouse moves, even when the computer is busy doing something else. If this routine is not called, the cursor jumps and moves sporadically on the screen as the mouse is moved. Until now, the only way to redraw the cursor when

PIANO: The Microsoft Mouse Tutorial Program

With the PIANO tutorial program, a user can practice moving the Mouse cursor around on a graphics screen. The program begins by drawing a three-octave piano keyboard on the monitor. Moving the Mouse cursor over one of the keys and pressing the left (primary) button causes that note to play. The action is like that of an organ (i.e., the note continues to play as long as the key is held down but stops immediately upon release). The octaves start on the note C and end on B. The second of the three octaves begins on middle C. Pressing the secondary (or right) button causes a note one octave higher to be played. To stop the program, simply press either Mouse button while the Mouse cursor is inside the box labeled "Quit."

As an example of the use of these function calls in an actual BASIC program, the complete source code to the piano demonstration (as written for the IBM PC) is given in listing 1 on page 138-143. The following is an explanation of the program details:

Line numbers	Comments
1000–1090	Copyright message
1100–1160	Set up music, clear graphics screen to blue.
1170–1250	Read in the frequencies for the various piano keys.
1260–1380	As explained in the text, this code locates the Mouse driver.
1390–1430	Function call 18 is performed to set the Mouse sensitivity. As set here, 3.2 inches of horizontal motion will move the cursor across the entire screen. This relatively high sensitivity was chosen so that songs could be played more rapidly. Accuracy is no problem because the piano keys are large.
1440–1620	The first cursor mask is defined. A logical AND operation is performed on the mask with the graphics screen. In conjunction with the Exclusive OR mask, a variety of cursor styles can be selected.
1630–1810	The Exclusive OR mask is defined. Because the entire AND mask was set to 1, wherever the Exclusive OR mask is set to 1 the screen will invert. The following table lists all the possibilities.

AND mask	XOR mask	Result
0	0	screen set to 0
0	1	screen set to 1
1	0	screen not changed
1	1	screen inverted

Line numbers	Comments
1820–1860	The Mouse driver is called to set the cursor shape. The cursor center is also defined. In this case, it is the tip of the arrow. The Mouse driver will automatically prevent the cursor center from leaving the screen.
1870–1930	These statements simply read in the Microsoft logo from precalculated data and put it on the screen.
1940–2150	The white and black (magenta) piano keys are drawn.
2160–2200	A box labeled "Quit" is drawn in the lower right corner.
2210–2250	A Mouse call is performed to move the Mouse cursor just under the piano keyboard near the center.
2250–2250	Mouse function 1 is performed to switch on the Mouse cursor.
2260–2290	The Mouse driver is called to give the status of the two Mouse buttons and the location of the screen cursor. This is probably the most common Mouse call used in applications.
2300–2370	Some decisions are made. If both Mouse buttons are up or if the Mouse is not on the piano keyboard, then any sound that might be playing is turned off.
2380–2430	At this point, the Mouse button is down over the quit box. The program turns off the Mouse cursor, clears the screen, and then quits.
2440–2510	The program has determined a button is down over the piano keyboard. These statements determine which key the Mouse cursor is over.
2520–2570	The note is played by the SOUND statement set with the correct frequency. This note is played in the background as the program loops back to line 2290.
2580–2630	This data contains the correct frequency to play the musical notes.
2640–3050	Data to draw the Microsoft logo using the PUT statement.

the mouse moved was to write an assembly-language routine using interrupts. Interrupts allow the computer to stop its current program, perform another task (such as updating the cursor), and then resume execution of the program. Unfortunately, assembly-language interrupt routines are difficult to write, and many BASIC programmers have been prevented from using mice for their application programs.

The extensive software provided with Microsoft's new Mouse does away with this problem. Three example programs are included: PIANO (see listing 1 on page 138 and the textbox above); LIFE (two mouse tutorials); and Multi-Tool Notepad (a mouse-driven text editor). In addition, three software packages are included for the programmer: MOUSE.COM and MOUSE.SYS provide a hardware-independent interface between the Mouse and an application program; MOUSE.LIB supports the use of the Mouse with Microsoft's compiled languages (Pascal, BASIC, FORTRAN, and COBOL). All of this software is compatible with MS-DOS (versions 1.1 and 2.0).

The most significant feature of this software is that the cursor will automatically track the Mouse every time it moves, no matter what other task the system is currently executing. The result is smooth, accurate cursor motion—even from interpreted BASIC programs, which are usually relatively slow.

Another unique feature of the software is the capability to alert the application program when the status of the Mouse has changed. Previously, programmers had to make periodic calls to the interface software to determine whether the mouse had

Text continued on page 136

Function Calls for the Microsoft Mouse

The details of the calls for the Microsoft Mouse (as written for the IBM PC) are listed here. The parameters are labeled M1%, M2%, M3%, and M4%, but they can have any legal variable names.

FUNCTION CALL 0 — Initialize the Mouse
Input:

  M1% = 0

Output:

  M1% = 0 if Mouse hardware not found, −1 otherwise
  M2% = Number of buttons on Mouse

  This call has the dual function of resetting the Mouse driver to default parameters.

FUNCTION CALL 1 — Show cursor
Input:

  M1% = 1
  CALL MOUSE (M1%, M2%, M3%, M4%)

Output:

  None, but a cursor tracking the Mouse will appear.

FUNCTION CALL 2 — Hide cursor
Input:

  M1% = 2
  CALL MOUSE (M1%, M2%, M3%, M4%)

Output:

  None, no cursor will track the Mouse. If the area of the screen containing the Mouse cursor is to be modified, the Mouse cursor must first be hidden. After the screen is modified the cursor is turned back on using CALL 1.

FUNCTION CALL 3 — Get Mouse cursor position and button status
Input:

  M1% = 3
  CALL MOUSE (M1%, M2%, M3%, M4%)

Output:

  M2% = Current state of buttons, 0 = button up
  M3% = Current horizontal cursor position (0–639)
  M4% = Current vertical cursor position (0–199)

  The Mouse cursor position is always defined on a virtual 640 by 200 screen. This is probably the most common call to the Mouse software.

FUNCTION CALL 4 — Set Mouse cursor position
Input:

  M1% = 4
  M3% = New horizontal cursor position (0–639)
  M4% = New vertical cursor position (0–199)
  CALL MOUSE (M1%, M2%, M3%, M4%)

Output:

  Mouse cursor will move to the desired location on the graphics screen.

FUNCTION CALL 5 — Get button-press information
Input:

  M1% = 5
  M2% = Button number (0 = left button, 1-right button)
  CALL MOUSE (M1%, M2%, M3%, M4%)

Output:

  M1% = Current state of buttons, 0 = button up
  M2% = Count of button presses since last M1% = 5 call
  M3% = Horizontal cursor position when button was last pressed

Text box continued on page 134

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M4% = Vertical cursor position when button was last pressed

FUNCTION CALL 6 — Get button-release information
Input:

M1% = 6
M2% = Button number
CALL MOUSE (M1%, M2%, M3%, M4%)

Output:

M1% = Current state of buttons, 0 = button up
M2% = Count of button releases since last M1% =6 call
M3% = Horizontal cursor position when button was last released
M4% = Vertical cursor position when button was last released

FUNCTION CALL 7 — Set minimum and maximum horizontal value
Input:

M1% = 7
M3% = Minimum horizontal Mouse-cursor position
M4% = Maximum horizontal Mouse-cursor position
CALL MOUSE (M1%, M2%, M3%, M4%)

Output:

This call will restrict the Mouse cursor to a certain area of the screen. If the cursor is outside this area when the call is made, it will be moved just inside the area. If minimum is greater than maximum, the two values will be swapped.

FUNCTION CALL 8 — Set minimum and maximum vertical value
Input:

M1% = 8
M3% = Minimum vertical Mouse-cursor position
M4% = Maximum vertical Mouse-cursor position
CALL MOUSE (M1%, M2%, M3%, M4%)

Output:

This call will restrict the Mouse cursor to a certain area of the screen. If the cursor is outside this area when the call is made, it will be moved just inside the area. If minimum is greater than maximum, the two values will be swapped.

FUNCTION CALL 9 — Set graphics cursor block
Input:

M1% = 9
M2% = Horizontal position of cursor center (0–15)
M3% = Vertical position of cursor center (0–15)
M4% = A 16 by 2 array dimensioned as:
DIM M4%(15,1)

First, a logical AND operation is performed on the 16 by 16 shape defined by M4% (aaa,0) with the graphics screen. Then, an Exclusive OR is performed on the second 16 by 16 cursor shape in M4% (xxx,1) and the result of the AND operation.

CALL MOUSE (M1%, M2%, M3%, M4%(0,0))

Output:

None, but the cursor style in graphics mode will reflect the new table values. If the screen is set for 320 by 200 four-color mode, the Mouse cursor will move only to even pixel locations on the 640 by 200 screen. In this case adjacent bits in the cursor are used to define the cursor color. For this reason, the horizontal cursor center should be an even number while in 320 by 200 graphics mode.

FUNCTION CALL 10 — Set text cursor
Input:

M1% = 10
M2% = 0 = Software cursor, 1 = hardware cursor

Text box continued on page 136

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M3% = A two-byte word. A logical AND operation is performed on M3% and the current text cursor location

— or —

the top scan line of hardware cursor

M4% = A two-byte word. An Exclusive OR operation is performed on M4% and the current text cursor location

— or —

the bottom scan line of hardware cursor

CALL MOUSE (M1%, M2%, M3%, M4%)

Output:

None, but the cursor style in text mode will reflect the new values.

FUNCTION CALL 11 — Read Mouse motion counters

Input:

M1% = 11

CALL MOUSE (M1%, M2%, M3%, M4%)

Output:

M3% = Horizontal mickey count since last M1% = 10 call (positive to the right) A mickey is the smallest unit of distance that can be resolved by the mouse.

M4% = Vertical mickey count since last M1% = 10 call (positive down)

A very low level call that is rarely used. See Call 15 for definitions.

FUNCTION CALL 12 — Set user-defined subroutine-call mask

Input:

M1% = 12

M3% = Set call mask whose bits are defined as follows:
bit 0 — call if cursor position changes
bit 1 — call if primary button is pressed
bit 2 — call if primary button is released
bit 3 — call if secondary button is pressed
bit 4 — call if secondary button is released

M4% = Offset of the machine-language subroutine, which will be called as a far procedure if any of the above conditions are met.

CALL MOUSE (M1%, M2%, M3%, M4%)

NOTE: The default mask is all zero, so no calls are generated.

Output:

If a bit in the call mask is set to 1, then the Mouse driver will perform a far call to the user-defined subroutine when that particular condition is met. When the routine is called, the registers will contain the following information.

AX = Mask containing reason routine was called

Text continued from page 131:

moved or not. This was wasteful because most of the time the mouse had not moved. With Microsoft's interface software, any time the status of the Mouse changes, the Mouse driver can execute a user-defined subroutine. Five conditions can be independently specified, and when any or all of these conditions are met, the subroutine is called. The application program can be alerted whenever the Mouse moves or when either of the two buttons on the Mouse is pressed or released.

Microsoft has provided several ways of accessing the interface software for the applications software developer. The assembly-language programmer simply loads the appropriate registers and issues a software interrupt; only the registers that pass back information are modified. For the programmer using Microsoft's compiled languages, routines in the library MOUSE.LIB will access the interface software. Those programmers using Microsoft's interpreted BASIC have access to the Mouse interface with the CALL statement. Optionally, the mouse may simulate the functions of a light pen, making it

BX = Button states, 0 = button up
CX = Horizontal position of Mouse cursor
DX = Vertical position of Mouse cursor

This routine is called before the on-screen cursor is updated, so it is ideal for changing the cursor shape, depending on its location on the screen or for drawing your own cursor.

FUNCTION CALL 13 — Light-pen emulation mode on
Input:
M1% = 13
CALL MOUSE (M1%, M2%, M3%, M4%)
Output:
None, but the light pen calls will return Mouse information. Because there is no concept of "pen down" or "pen off screen" with a Mouse, some compromises will have to be made. The Mouse is "down" if the primary or secondary button is down, and "up" if the primary or secondary button is up. By default light-pen emulation is on.

FUNCTION CALL 14 — Light-pen emulation off
Input:
M1% = 14
CALL MOUSE (M1%, M2%, M3%, M4%)
Output:
None, light-pen emulation stops.

FUNCTION CALL 15 — Set mickey/pixel ratio
Input:
M1% = 15
M3% = Number of mickeys required to move 8 horizontal screen pixels
M4% = Numberof mickeys required to move 8 vertical screen pixels
CALL MOUSE (M1%, M2%, M3%, M4%)
NOTE: 1 mickey = 1 Mouse increment
1 pixel = 1 640 by 200 picture element
Output:
None, but the amount that the Mouse must be moved to move the cursor will vary according to the inputs. Note that this mickey/pixel ratio is defined on a (possibly) virtual 640 by 200 screen. The Mouse driver will automatically compensate for lower-resolution screens. The default value for the horizontal mickey/pixel ratio is 8. The default vertical value is 16. This means that it will take 6.4 inches of Mouse travel to move across the screen horizontally and 4.0 inches of travel to move across the screen vertically. This distance is independent of the current screen mode.

simple to retrofit existing programs by using the light-pen statements built into BASIC (and other languages).

Calling Your Mouse

Although there are 16 different Mouse functions available to the programmer, they are all called in the same way (see "Function Calls," page 132). A procedure named MOUSE is executed via the CALL statement in the format

CALL MOUSE (*n*, *n*, *n*, *n*)

Four interior parameters are always specified, even though some of them may be dummy values. The parameters can have any legal variable name, but in the examples here, they will always be labeled M1%, M2%, M3%, and M4%. The % means that the variables are integers. The first parameter (M1%) specifies which of the 16 functions are to be executed. Lines 1260 through 1380 in listing 1 on page 138 must be executed before any Mouse calls are performed to determine where the MOUSE function is located in memory (all example programs are designed to run on the IBM Personal Computer).

The Mouse cursor is made up of 16 by 16 points, its shape is definable from application programs, and it can be used in all screen modes. The cursor always appears to move over the data on the screen. As it continues to move, the shapes are restored to the screen.

Summary

The Microsoft Mouse makes mouse capabilities available to users of the IBM PC and computers running under MS-DOS, without requiring assembly-language programming and at an inexpensive price. It opens up the possibility of a whole new generation of software. With the Microsoft Mouse and interface software, the independent software writer can easily develop mouse-based applications. ■

About the Author

Chris Peters is a systems software engineer at Microsoft Corporation (10700 Northup Way, Bellevue, WA 98004). In addition to the Mouse Project, he worked on Microsoft's Softcard and helped develop MS-DOS 2.0.

Listing 1: *The source code of the VIRTUAL PIANO demonstration program, written in IBM PC BASIC.*

```
1000 '
1010 '                THE VIRTUAL PIANO
1020 '
1030 '     COPYRIGHT (C) 1983 BY MICROSOFT CORPORATION
1040 '             WRITTEN BY CHRIS PETERS
1050 '
1060 '----------------------------------------------------
1070 '
1080 '   I N T I A L I Z E
1090 '
1100 DEFINT A-Z
1110 DIM CURSOR(15,1),FREQ(27,2),MICROSOFT(839)
1120 KEY OFF
1130 PLAY"MF"
1140 SCREEN 1
1150 COLOR 1,1
1160 CLS
1170 '
1180 '   Read in the flat, normal, and sharp note frequencies
1190 '
1200 FOR J=0 TO 2
1210 FOR I=0 TO 6
1220 READ K
1230 FREQ(I,J)=K : FREQ(I+7,J)=K*2 : FREQ(I+14,J)=K*4 : FREQ(I+21,J)=K*8
1240 NEXT
1250 NEXT
1260 '
1270 '   Determine Mouse Driver location, if not found, quit.
1280 '
1290 DEF SEG=0
1300 MSEG=256*PEEK(51*4+3)+PEEK(51*4+2)      ' Get mouse segment
1310 MOUSE=256*PEEK(51*4+1)+PEEK(51*4)+2     ' Get mouse offset
1320 IF MSEG AND MOUSE THEN 1370
1330 PRINT"Mouse driver not found"           ' Not found, so print error.
1340 PRINT
1350 PRINT"Press any key to return to system"
1360 I$=INKEY$ : IF I$="" THEN 1360 ELSE SYSTEM
1370 DEF SEG=MSEG                           ' Set mouse segment
1380 M1 = 0 : CALL MOUSE(M1,M2,M3,M4)       ' Initialize the mouse
1390 '
1400 '   Set Mouse sensitivity
1410 '
1420 M1 = 15 : M3=4 : M4=8
1430 CALL MOUSE(M1,M2,M3,M4)
```

Listing 1 continued on page 141

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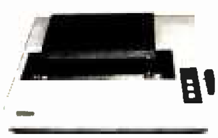

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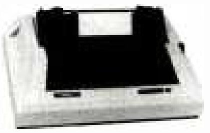

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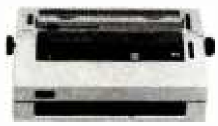

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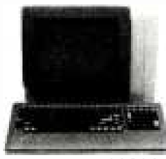

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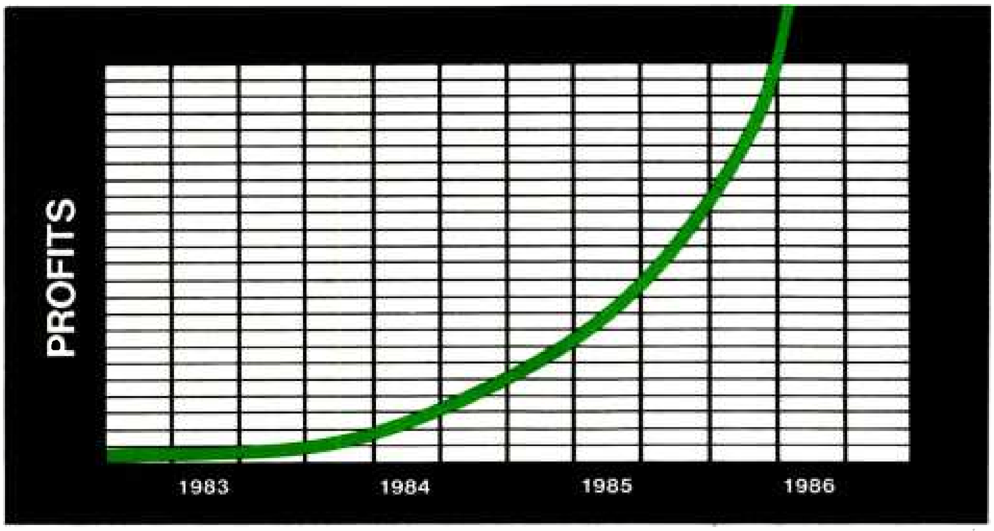
Listing 1 continued:

```
1440 '
1450 '  Define the "logical and" cursor mask
1460 '
1470 CURSOR( 0,0)=&HFFFF          ' Binary 1111111111111111
1480 CURSOR( 1,0)=&HFFFF          ' Binary 1111111111111111
1490 CURSOR( 2,0)=&HFFFF          ' Binary 1111111111111111
1500 CURSOR( 3,0)=&HFFFF          ' Binary 1111111111111111
1510 CURSOR( 4,0)=&HFFFF          ' Binary 1111111111111111
1520 CURSOR( 5,0)=&HFFFF          ' Binary 1111111111111111
1530 CURSOR( 6,0)=&HFFFF          ' Binary 1111111111111111
1540 CURSOR( 7,0)=&HFFFF          ' Binary 1111111111111111
1550 CURSOR( 8,0)=&HFFFF          ' Binary 1111111111111111
1560 CURSOR( 9,0)=&HFFFF          ' Binary 1111111111111111
1570 CURSOR(10,0)=&HFFFF          ' Binary 1111111111111111
1580 CURSOR(11,0)=&HFFFF          ' Binary 1111111111111111
1590 CURSOR(12,0)=&HFFFF          ' Binary 1111111111111111
1600 CURSOR(13,0)=&HFFFF          ' Binary 1111111111111111
1610 CURSOR(14,0)=&HFFFF          ' Binary 1111111111111111
1620 CURSOR(15,0)=&HFFFF          ' Binary 1111111111111111
1630 '
1640 '  Define the "exclusive or" cursor mask
1650 '
1660 CURSOR( 0,1)=&H300          ' Binary 0000001100000000
1670 CURSOR( 1,1)=&H300          ' Binary 0000001100000000
1680 CURSOR( 2,1)=&HFC0          ' Binary 0000111111000000
1690 CURSOR( 3,1)=&HFC0          ' Binary 0000111111000000
1700 CURSOR( 4,1)=&H3FF0          ' Binary 0011111111110000
1710 CURSOR( 5,1)=&H3FF0          ' Binary 0011111111110000
1720 CURSOR( 6,1)=&HFCFC          ' Binary 1111110011111100
1730 CURSOR( 7,1)=&HC00C          ' Binary 1100000000001100
1740 CURSOR( 8,1)=&H0          ' Binary 0000000000000000
1750 CURSOR( 9,1)=&H0          ' Binary 0000000000000000
1760 CURSOR(10,1)=&H0          ' Binary 0000000000000000
1770 CURSOR(11,1)=&H0          ' Binary 0000000000000000
1780 CURSOR(12,1)=&H0          ' Binary 0000000000000000
1790 CURSOR(13,1)=&H0          ' Binary 0000000000000000
1800 CURSOR(14,1)=&H0          ' Binary 0000000000000000
1810 CURSOR(15,1)=&H0          ' Binary 0000000000000000
1820 '
1830 '  Set the mouse cursor shape
1840 '
1850 M1 = 9 : M2 = 6 : M3 = 0
1860 CALL MOUSE(M1,M2,M3,CURSOR(0,0))
1870 '
1880 '  Draw the MICROSOFT logo from pre-calculated data
1890 '
1900 FOR I=0 TO 779
1910 READ MICROSOFT(I)
1920 NEXT
1930 PUT(62,0),MICROSOFT,PSET
1940 '
1950 '  Initialize keyboard size parameters
1960 '
1970 YL = 60 : WKL = 80 : BKL = 45 : KW = 15 : WKN = 21
1980 XL = 320-KW*WKN : YH = YL + WKL : XH = 319 : BKW2=KW\3
1990 QX = 272 : QY = 176
2000 '
2010 '  Draw the white keys
2020 '
2030 LINE (XL,YL)-(XH,YH),3,BF
2040 FOR I=XL TO XH STEP KW
2050 LINE (I,YL)-(I,YH),0
2060 NEXT
2070 '
2080 '  Draw the "black" keys
2090 '
2100 C=6
2110 FOR X=XL TO XH STEP KW
2120 C=C+1 : IF C=7 THEN C=0
2130 IF C=0 OR C=3 THEN 2150
2140 LINE(X-BKW2,YL)-(X+BKW2,YL+BKL),2,BF
2150 NEXT
2160 '
2170 '  Draw the quit box
2180 '
2190 LINE(QX,QY)-(319,199),3,B
2200 LOCATE 24,36 : PRINT"Quit";
2210 '
2220 '  Set mouse cursor location, then turn on cursor
2230 '
2240 M1 = 4 : M3 = 320 : M4 = 160 : CALL MOUSE(M1,M2,M3,M4)
2250 M1 = 1 : CALL MOUSE(M1,M2,M3,M4)
2260 '
2270 '   M A I N   L O O P
2280 '
2290 M1=3 : CALL MOUSE(M1,BT,MX,MY)      ' Get mouse location and button status
2300 IF (BT AND 2) THEN OTV=7 : GOTO 2340     ' If right button down, set high oct
ave
2310 IF (BT AND 1) THEN OTV=0 : GOTO 2340     ' If left button down, set lower oct
ave
2320 SOUND 442,0                          ' If both buttons up, turn off sound
2330 GOTO 2290                            ' Keep looping...
2340 MX = MX\2                            ' Correct for medium resolution screen
2350 IF MX <= XL OR MY < YL THEN 2320     ' If above keyboard, turn off sound
2360 IF MY <= YH THEN 2470                ' If on keyboard, play sound
2370 IF MY < QY OR MX < QX THEN 2320      ' If above quit box, turn off sound
2380 '
2390 '  Button down inside the quit box
```

Listing 1 continued on page 143

Keep your bottom line on the up and up and up.



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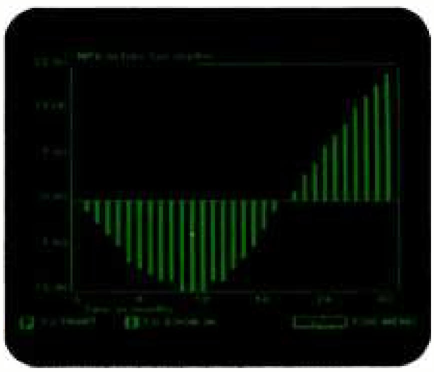

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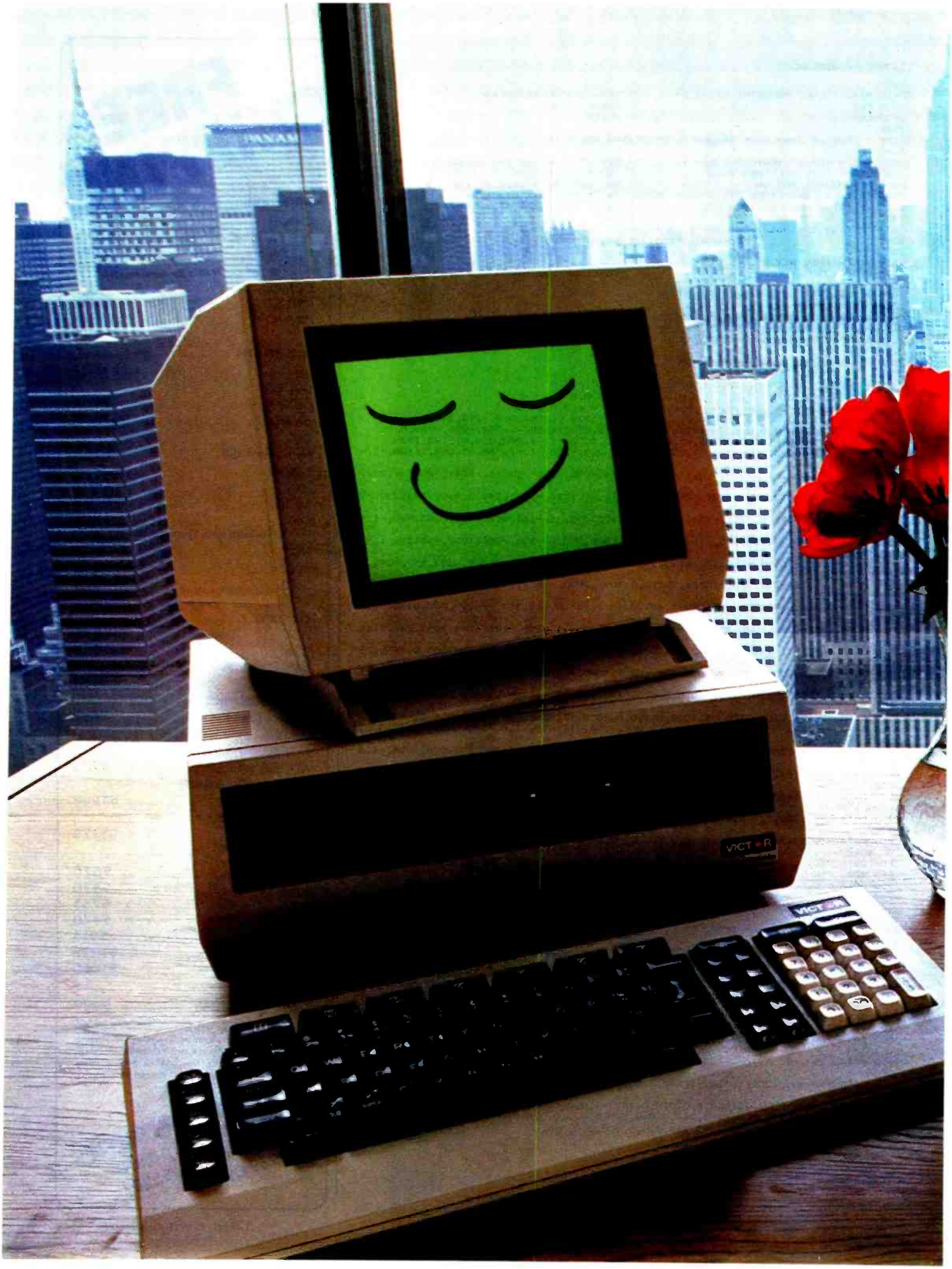
Listing 1 continued:

```
2400 '
2410 M1=2 : CALL MOUSE(M1,M2,M3,M4)      ' Turn off mouse cursor
2420 CLS                                 ' Clear screen
2430 END                                 ' quit
2440 '
2450 '   Button down over keyboard, determine which key
2460 '
2470 WKY = (MX-XL)\KW+OTV : R = 1         ' Get which white key cursor is over
2480 IF MY > YL+BKL THEN 2560            ' is it lower than the black keys?
2490 MK=(MX-XL) MOD KW                   ' No, get which side of key
2500 IF MK <= BKW2 THEN R=0 : GOTO 2560 ' Is it the left black key?
2510 IF MK >= KW-BKW2 THEN R=2           ' Is it the right black key?
2520 '
2530 '   Play the note. For BASIC interpreter duration = 2
2540 '                  For BASIC compiler    duration = 1
2550 '
2560 SOUND FREQ(WKY,R),2
2570 GOTO 2290                           ' Continue looping
2580 '
2590 '   Musical note frequencies
2600 '
2610 DATA 131,139,156,175,185,208,233
2620 DATA 131,147,165,175,196,220,247
2630 DATA 139,156,165,185,208,233,247
2640 '
2650 '    Data to draw the MICROSOFT logo
2660 '
2670 DATA 462,28,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
2680 DATA 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
2690 DATA 0,0,0,-193,240,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
2700 DATA 0,0,0,0,0,768,-1,0,0,0,0,3840,-1,-16129,0,-253,0,0,-193,240
2710 DATA 0,0,0,0,0,0,0,0,0,-193,0,16128,4095,252,16128,-1,240,-256,-769,0
2720 DATA 0,0,0,0,-193,240,768,-1,255,768,-1,1023,-1,-1,240,0,0,0,-193,192
2730 DATA -256,4095,252,-253,-1,255,-256,-1,240,-253,-1,-1,768,-1,255,16128,-1,-
3841,768,-1
2740 DATA 1023,-1,-1,240,0,0,0,-193,192,-256,4095,252,-193,-1,-3841,-256,-1,252,
-1009,0
2750 DATA -256,4032,-1,-16129,-253,-1,-1,768,-1,1023,-1,-1,240,0,0,0,-193,240,-2
53,4095
2760 DATA 252,-3841,0,-961,-256,-1,255,0,0,0,3840,-1,-16129,-241,0,-253,960,-1,1
023,-1
2770 DATA -1,240,0,0,0,-193,240,-253,4095,1020,255,0,-253,-256,4032,-16129,-1,-1
,-1,4092
2780 DATA 4095,-16129,-4033,0,16128,1008,-1,1023,-1,-1,240,0,0,0,-193,252,-241,4
095,1020,252
2790 DATA 0,-256,-256,960,-15361,252,0,0,4095,1023,-16129,-16321,0,3840,1008,255
,0,3840,252,0
2800 DATA 0,0,0,-193,252,-241,4095,4092,240,0,16128,-64,192,-16129,0,0,0,3840,25
5,0
2810 DATA 255,0,768,1020,255,0,3840,252,0,0,0,0,-193,255,-193,4095,4092,240,0,16
128
2820 DATA -64,192,-12289,-1,192,-241,-12289,-3841,0,255,0,768,1020,255,0,3840,25
2,0,0,0
2830 DATA 0,-193,255,-193,4095,16380,192,0,3840,-16,960,-12289,240,0,0,-15553,-1
,768,252,0
2840 DATA 0,1023,255,0,3840,252,0,0,0,0,-193,-16129,-1,4095,16380,192,0,0,-256,4
032
2850 DATA -16129,0,0,0,768,-1,1008,252,0,0,1023,-1,255,3840,252,0,0,0,0,-3265
2860 DATA -16129,-3073,4095,16380,192,0,0,-256,-1,4095,-1,0,-253,-16129,-1,1020,
252,0,0,1023
2870 DATA -1,255,3840,252,0,0,0,0,-3265,-3073,-3073,4095,16380,192,0,0,-256,-1,4
095,240
2880 DATA 0,0,-16321,-241,1023,252,0,0,1023,-1,255,3840,252,0,0,0,0,-4033,-3073,
-15361
2890 DATA 4095,16380,192,0,0,-256,-1,252,0,0,0,0,16128,-15361,252,0,0,1023,-1,25
5
2900 DATA 3840,252,0,0,0,0,-4033,-1,-15361,4095,16380,192,0,0,-256,-1,4092,240,0
,0
2910 DATA -16321,768,-3073,252,0,0,1023,255,0,3840,252,0,0,0,0,-4033,-193,1023,4
095,4092
2920 DATA 240,0,0,-256,-64,4092,-1,192,-241,-16129,0,-3841,255,0,768,1020,255,0,
3840,252
2930 DATA 0,0,0,0,-4033,-193,1023,4095,4092,240,0,16128,-64,4032,255,0,0,0,16128
,252
2940 DATA -3841,255,0,768,1020,255,0,3840,252,0,0,0,0,-4033,-241,1020,4095,1020,
252,0
2950 DATA -256,-256,960,1023,252,0,0,16383,1023,-3841,-16321,0,3840,1008,255,0,3
840,252,0,0
2960 DATA 0,0,-4033,-241,1020,4095,1020,255,0,-253,-256,960,-16129,-1,-1,-1,1638
0,-1,-3841,-4033
2970 DATA 0,16128,1008,255,0,3840,252,0,0,0,0,-4033,-253,1008,4095,252,-3841,0,-
961,-256
2980 DATA 192,-16129,0,0,0,3840,-1,-16129,-241,0,-253,960,255,0,3840,252,0,0,0,0

2990 DATA -4033,-253,1008,4095,252,-193,768,-3841,-256,192,-16129,-1009,0,-256,4
032,-1,255,-253,240,-193
3000 DATA 768,255,0,3840,252,0,0,0,0,-4033,-256,960,4095,252,-253,-1,255,-256,19
2,-16129
3010 DATA -253,-1,-1,768,-1,252,16128,-1,-3841,768,255,0,3840,252,0,0,0,0,-4033,
-256
3020 DATA 960,4095,252,16128,-1,240,-256,192,-16129,0,0,0,0,-193,192,768,-1,255,
768,255
3030 DATA 0,3840,252,0,0,0,0,0,0,0,0,768,-1,0,0,0,0,3840,-1
3040 DATA -16129,0,0,0,0,-193,240,0,0,0,0,0,0,0,0,0,0,0,0
3050 DATA 0,0,0,0,0,0,0,0,-193,240,0,0,0,0,0,0,0,0,0,0
```

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Benchmarking the Intel 8086 and 8088

The 8086 is faster than the 8088, but there's more than execution speed to consider when selecting a computer.

by Gregg Williams

The Intel 8086 (iAPX 86) owes much of its popularity to its introduction in 1978 as one of the first 16-bit microprocessors. That same year, Intel also introduced the 8088 (iAPX 88), a companion microprocessor that is virtually identical to the 8086 but that communicates over an 8-bit data path rather than the 8086's 16-bit path. From its introduction, the 8088's lower price and its familiarity to designers of 8-bit systems have made it the microprocessor of choice in an increasing number of applications. And when IBM chose the 8088 for its Personal Computer, the chip surpassed the 8086 in popularity.

Component price is an important criterion because of its effect on system price, but the relative performance of the two microprocessors should be weighed in the context of complete system price and performance. To more fully explore the merits of the two devices, BYTE conducted a benchmark study that should help anyone who's faced with choosing between systems built with either microprocessor.

The results of that benchmark study show that the 8088 is slower than the 8086, varying from 10 percent to 20 percent slower for numeric-intensive applications to as much as 40 percent slower for other applications (see tables 1 and 2). The main reason for the popularity of the 8088 in computers available today remains the difference in the price of the chips two to three years ago, when these machines were designed. And although that price differential has decreased significantly, system manufacturers may still choose the 8088 because of the price advantage it gives them in a highly competitive market.

Description	Execution Times 8086	Execution Times 8088	Ratio 8086/8088
empty-loop benchmark (BASIC)	4.24	6.00	1.42
GOSUB benchmark (BASIC)	8.19	11.5	1.40
30,000 additions (BASIC)	61.4	86.0	1.40
5000 square roots and multiplications (BASIC)	38.0	53.2	1.40
Gilbreath sieve benchmark (BASIC)	147.	205.	1.39
MID$ benchmark (BASIC)	14.6	20.3	1.39
C = A/B benchmark (BASIC)	12.6	17.5	1.39
unoptimized bubble sort (assembly language)	71.4	89.9	1.26
graphics-scaling routine (assembly language)	55.4	60.1	1.08

Table 1: *Real-world benchmarks that execute groups of assembly-language instructions. All results are accurate to three significant digits. For more details, see the text boxes, figure 2, and listing 2.*

Historical Considerations

When the 8086 and 8088 were first introduced, their prices, in quantity, were about $97 and $48, respective-

Description	8086 Recorded	8086 Empty Loop	8086 True Time	8088 Recorded	8088 Empty Loop	8088 True Time	Ratio 8088/8086
4 ADD AX,1	26.5	11.4	15.1	44.2	13.9	30.3	2.01
4 ADD AL,1	21.5	11.4	10.1	34.1	13.9	20.2	2.00
4 XCHG BL,AL	21.5	11.4	10.1	34.1	13.9	20.2	2.00
4 XCHG BX,AX	21.5	11.4	10.1	34.1	13.9	20.2	2.00
4 MOV [30],AX	41.6	11.4	30.2	69.4	13.9	55.5	1.84
4 MOV AX,[30]	39.2	11.4	27.8	64.4	13.9	50.5	1.82
4 ADD AX,[30]	51.1	11.4	39.7	79.4	13.9	65.5	1.65
4 MOV [30],AL	41.6	11.4	30.2	59.3	13.9	45.4	1.50
4 ADD AL,[30]	51.1	11.4	39.7	69.3	13.9	55.4	1.40
4 MOV [31],AX	51.7	11.4	40.3	69.4	13.9	55.5	1.38
4 near JMPs	56.8	11.4	45.4	69.4	13.9	55.5	1.22
4 MUL WORD [30] *	120.	3.80	116.	125.	4.63	120.	1.04
4 MUL BYTE [30] *	76.1	3.80	72.3	77.6	4.63	73.0	1.01
4 short JMPs	56.7	11.4	45.3	59.2	13.9	45.3	1.00

Table 2: *Pure benchmarks of individual 8086 assembly-language instructions. All results are accurate to three significant digits. The MUL instructions (marked with asterisks) differ from the others in having an outer loop executed 10 (hexadecimal) times. For more details, see the text boxes, figures 1 and 2, and listing 1.*

ly—a difference of $49. In addition, an 8086-based system design required several more chips: a bidirectional bus transceiver (such as the Intel 8286) to transmit and receive the top 8 bits of the data bus and several TTL (transistor-transistor-logic) chips to organize the memory into 16-bit words. These chips added about $6 in parts to the 8086-based design, for a total price differential of about $55. Given the designer's rule of thumb that the final price of a product (because of extra labor, documentation, circuit-board area, product support, price markup, and other factors) is three to six times the actual component cost, the use of an 8086 over an 8088 in 1978 meant an increase in the product cost of between $165 and $330; using $250 as a compromise figure, the cost of the 8086 represented about 8 percent of the selling price of a $3000 computer. Although this was not a prohibitive expense, it was taken seriously by many manufacturers.

These factors influenced the design of systems such as the IBM Personal Computer (introduced in August 1981, work on its design began in early 1980) and the Texas Instruments Professional Computer (introduced in February 1982, work on its design began in early 1981). The extra-components cost of an 8086-based system is lower than $250 now (more on that later), but it was probably close to that in 1981 and even closer in 1980.

Bill Skelton, hardware manager of the Texas Instruments Professional Computer, says that cost considerations influenced the design of the TI machine. "The 8088 led us to a lower-cost solution in terms of manufacturing costs," he says, but the price differential for components alone was "in a range of a few tens of dollars versus a few hundreds of dollars when TI made its system." He very roughly estimated the manufacturing cost to be $40 to $50, raising the final price by $125 to $200. But, he says, "the $3000 machine market is intensely competitive—even a few hundred dollars' price difference is important."

It is reasonable to infer that the IBM PC would run BASIC about 40 percent faster if IBM had designed it using an 8086.

Although the design of the TI PC was swayed by cost considerations, it was also influenced by the IBM PC (to which it still bears a faint similarity) and other factors. One subtle advantage of the 8088 over the 8086, Skelton says, is its ability to be configured as a 64K-byte system using cost-effective 64K-bit memory chips. (The smallest 8086-based system that can be designed using 64K-bit chips is a 128K-byte system.) A minimum configuration of 64K bytes is attractive to most manufacturers because it enables them to offer a system with a lower base price—a point that was probably not lost on IBM, which also designed a minimal 64K-byte system.

When the TI PC was being designed, Skelton says, the 8086 was not a serious contender. Given the prices of the various chips at the time, "the real controversy was the Z80 versus the 8088, not the 8086 versus the 8088." He continues, "The payoff on the 8088 is not its performance but its ability to have huge amounts of memory" compared to the 8-bit Zilog Z80, which can address a maximum of 64K bytes. In this light, the 8088 was the obvious choice for TI.

Present Price and Benchmark Considerations

The 8086 now sells for $30 in quantity, the 8088 for $20. Because chip prices have fallen and the price differential between the two processors has narrowed, the component price differential is now about $16. At a markup of three to six times, the price difference between an 8088-based system and its equivalent 8086-based counterpart is $48 to $96. Although

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this is not the economic handicap it used to be, it will still influence manufacturers in favor of the 8088.

Setting aside price as a system selection criterion for the moment, it's time to consider the benchmark results in detail. The BYTE study consisted of real-world and "pure" benchmarks. The numeric results of the real-world benchmarks are given in table 1; those of the pure benchmarks are in table 2. Figure 1 shows the execution time of selected assembly-language instructions for each of the two chips (8086 and 8088) and for each of the two possible data lengths (8- and 16-bit). Figure 2 shows the execution time ratio of the 8088 to the 8086 for selected pure and real-world benchmarks. (The results shown here are representative of a larger number of measurements that were taken while researching this article.) The text box on page 154 contains further information.

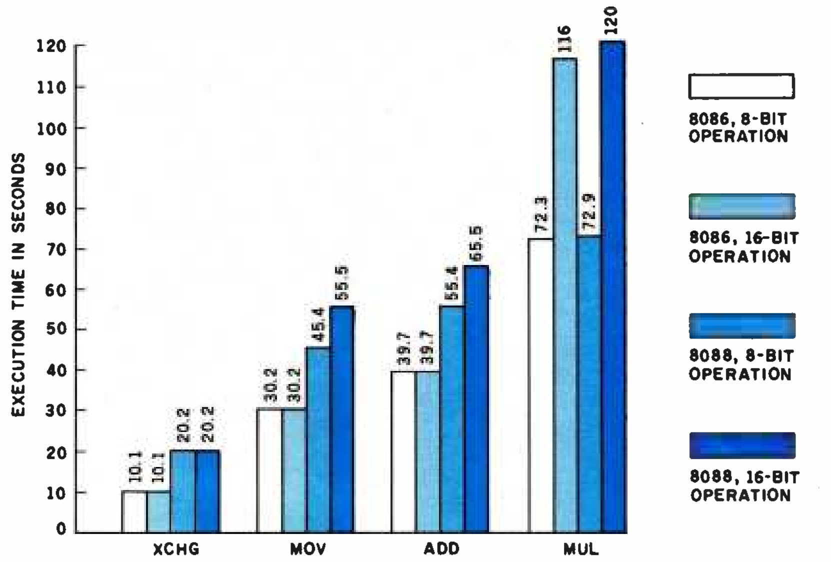


Figure 1: *A comparison of representative 8086 instructions by processor (8086 versus 8088) and operand length (8 versus 16 bits).*

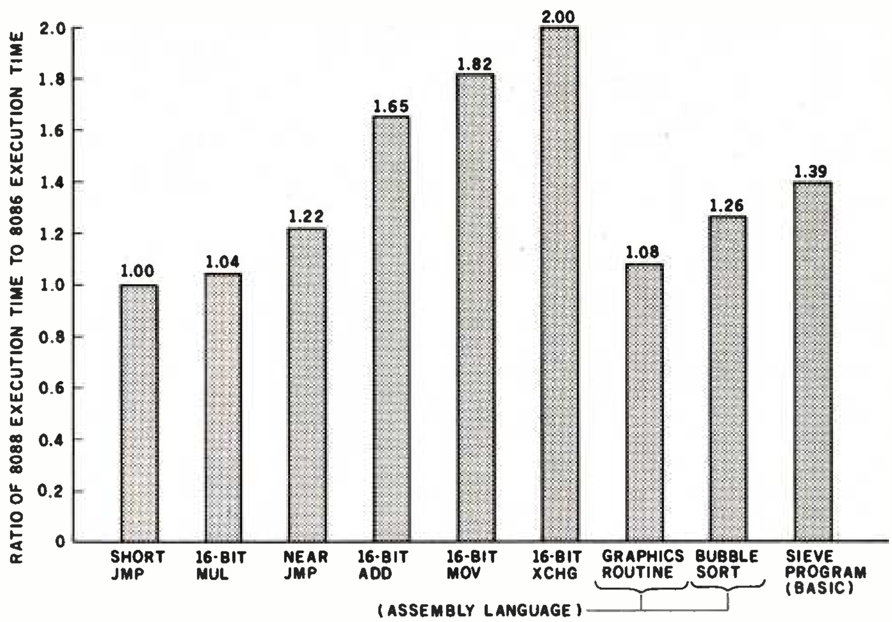


Figure 2: *Performance ratios for selected pure and real-world benchmarks. The ratios are obtained by dividing the execution time of the 8088 for that benchmark by the execution time of the 8086. The first six bars are derived from the pure benchmarks of table 2; the last three are from the real-world benchmarks of table 1.*

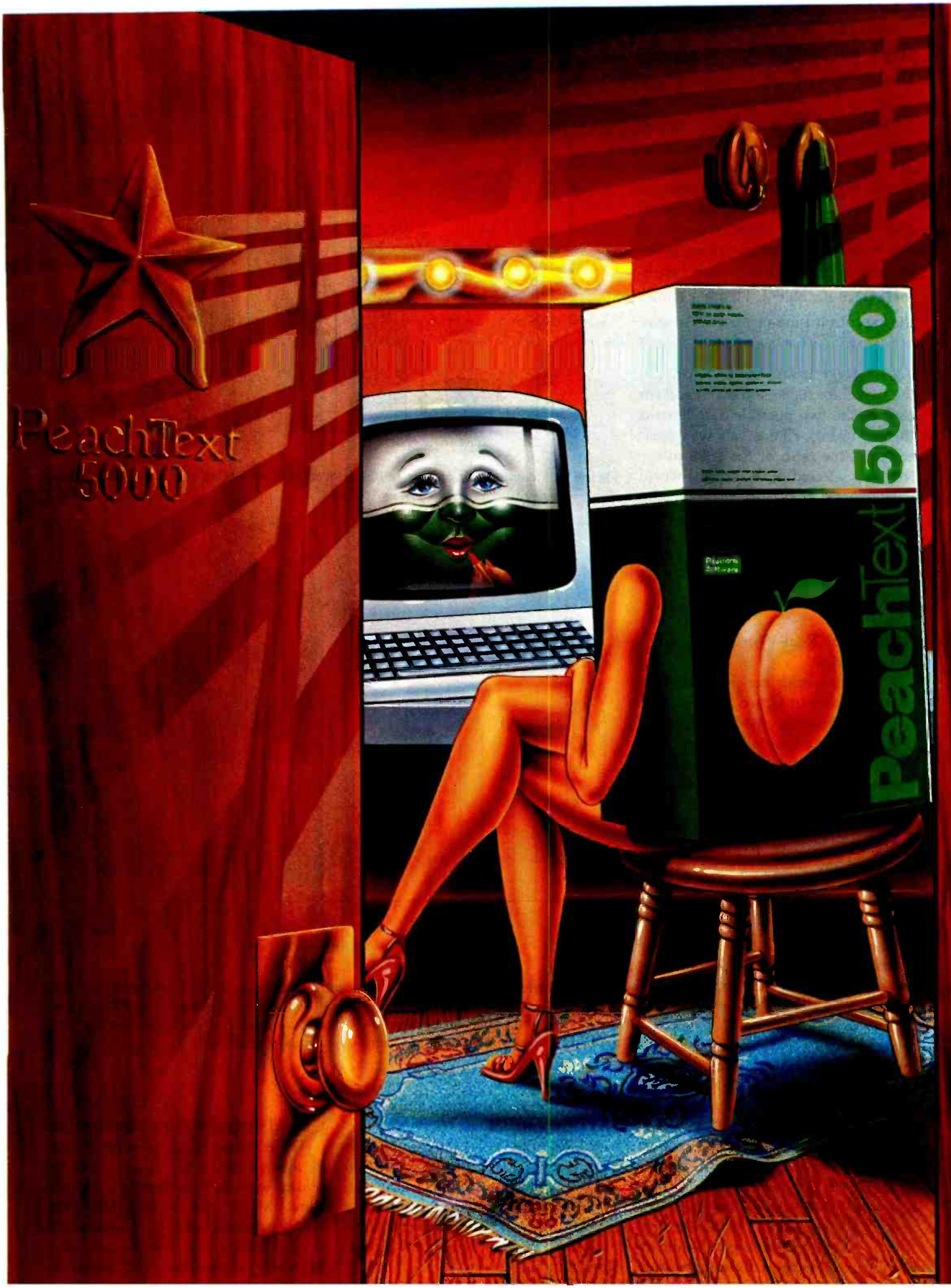
Analysis of Real-World Benchmarks

The real-world benchmarks (the last three bars in figure 2) show that the 8088 performs much better with the numeric-intensive graphics routines than it does with the data-movement-intensive bubble sort or the BASIC sieve program. This result agrees with the conclusions reached about the relative performance of numeric- and data-intensive instructions. All the BASIC benchmark programs produce almost identical statistics (see table 1), implying that the 8088-to-8086 execution ratio (dictated by the underlying instruction mix being executed) does not change much regardless of the BASIC program being interpreted.

If the real-world benchmarks are more accurate indicators of the relative performances of the 8086 and 8088 microprocessors, we can generalize, very roughly, that numeric-intensive applications are about 10 percent slower on the 8088 compared to the same program running on an equivalent 8086-based system with 16-bit-wide memory. That's assuming the program executes a good number of multiplication and division instructions; if it executes primarily addition and subtraction instructions, the performance of the 8088 will be considerably slower. Data-intensive applications may be about 25 percent slower; however, the performance of a BASIC interpreter indicates that some programs will be about 40 percent slower.

Considering the Pure Benchmarks

The 8088 performs poorest (figure 2) against the 8086 in pure benchmarks with data-movement instructions (MOV and XCHG) and best with program-control instructions (JMPs). There is a seeming paradox, however, in that the 8088 performs


PeachText
5000
5000
PeachText
Peachtree
Software

Technical Details About the Benchmarks

The hardware we used included a 20-slot terminated Compupro High-Performance Motherboard, Compupro's floppy-disk system (two 8-inch Qume floppy-disk drives), and computer boards from Lomas Data Products. The Lomas boards were the Lightning One processor board (which can use the 8086 or the 8088 microprocessor as well as the 8087 arithmetic or 8089 I/O coprocessor chips), the RAM67 128K-byte CMOS static RAM board, the Hazitall system support board (used for a serial port to a Wyse WY-100 terminal), and the LDP72 floppy-disk interface board. The software we used included Digital Research's CP/M-86 version 1.1 (used for all the benchmarks except BASIC), Microsoft's MS-DOS version 1.10, and Microsoft's MBASIC-86 revision 5.21.

Each benchmark was executed three times; execution times were recorded to the nearest hundredth of a second, averaged, and rounded to three significant digits. For the assembly-language benchmarks listed in table 1, the actual benchmark programs are created by inserting four copies of a given instruction into the framework of listing 1a; a sample program is given in listing 1b. The final benchmark time associated with a given instruction is its benchmark execution time minus that of an empty loop. The JMP benchmarks use four JMPs, each of which points to the instruction after it. Because the MUL instructions were relatively slow, their benchmark programs substituted "MOV SI,$10" for "MOV SI,$30" as the first instruction.

The bubble-sort and graphics-scaling routines mentioned in table 2 are given in listings 2a and 2b. The bubble sort sorts a list of 2048 16-bit data elements. The graphics-scaling routine takes a list of 16 x,y pairs and creates a list of altered x', y' pairs by the formulas $x'=(21/4)(x-15)$ and $y'=(21/4)(y-8)$; you might perform this graphics operation on a list of data points to be viewed in a different way. The empty-loop, GOSUB, MID$, and "C=A/B" BASIC benchmarks are simple BASIC instructions executed in a loop 5000 times. These four benchmarks and a modified Sieve of Eratosthenes benchmark—popularized by Jim Gilbreath—are listed in the January 1982 BYTE, *p. 54. The addition and square root/multiplication programs of table 2 are given in listings 2c and 2d.*

(Note to nitpicking readers: please do not write in with improvements to the bubble-sort program in listing 2a. It is admittedly slow and could be replaced by a better method or improved by bumping the beginning comparison point after each pass through the table of values. Nevertheless, this program has the ability to exercise data-movement instructions heavily and fulfills the prime requirement of a benchmark—to be an arbitrary program that can be run in different situations—in this case, on different microprocessors—to provide data with which to make comparisons.)

The Benchmark Conditions

An analysis of the 8086 and 8088 chips would be worthless without some quantitative evidence, so an environment was devised in which meaningful comparisons could be made. Hardware included a Compupro High-Performance Motherboard (an S-100 motherboard with active termination) and a set of S-100 boards from Lomas Data Products. The Lomas boards were chosen because they allowed easy switching between an 8086-based system using 16-bit memory and an 8088-based system using 8-bit memory. In particular, the Lightning One central processing unit board can hold either an 8086 or an 8088 in the same socket; it senses the chip being used and reconfigures the RAM67 memory board to reorganize itself as either 8 bits wide (for the 8088) or 16 bits wide (for the 8086).

Various individual 8086 instructions were benchmarked by executing them repeatedly in a loop (both chips will execute identical 8086 machine-language code) using Digital Research's CP/M-86 operating system and DDT86 debugging program. To assure that the final benchmark execution time reflected that of executing the instruction under examination, an empty loop was executed (i.e., the same program as described above, but without the 8086 instruction being tested) for each machine, and this time was subtracted from the loop-plus-instruction execution time. These are the "pure" benchmarks because they test the performance of single assembly-language instructions; the final benchmark figures, sorted in decreasing amount of speed difference, are given in table 2.

As a second level of benchmark, several assembly-language programs of varying lengths were tested. One, an unoptimized bubble-sort routine, moves a lot of 16-bit quantities, which should emphasize any execution-speed weakness of the 8088. Another, a graphics-scaling routine, involves much numeric calculation and little data movement, which should emphasize the relative merits of both chips in numeric-intensive applications.

As a final level of benchmark, BYTE'*s BASIC benchmarks were timed. These were first described in a review of the IBM Personal Computer (January 1982, p. 54). The programs ran under Microsoft's MS-DOS operating system and its MBASIC language. To that were added two BASIC programs that did, respectively, 5000 square-root and multiplication operations and 30,000 floating-point additions. Because MBASIC is an interpreted language, the BASIC benchmarks should be considered as real-world assembly-language benchmarks along with the programs mentioned above.* —G.W.

almost identically to the 8086 on a 16-bit multiply instruction but fares much worse on a 16-bit addition.

Figure 1 shows some interesting secondary information about the 8086 and the 8088 microprocessors. Each group of four bars represents the execution times for the 8086 doing an 8- and 16-bit version of the same operation, followed by the 8088 doing the same 8- and 16-bit operation. The 8088 operates more slowly than the 8086, and the 8088 performs 8-bit operations faster than equivalent 16-bit ones. But the 8086 takes exactly the same time to do some operations in both their 8- and 16-bit versions. The times are identical for XCHG (exchange the contents of two registers) and MOV (move from register to memory) and only slightly

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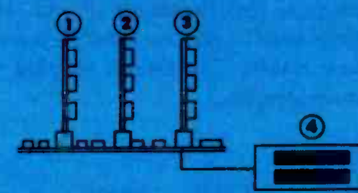

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Listing 1: *(1a) Prototype of and (1b) example of the pure assembly-language benchmarks used to test the Intel 8086 and 8088 microprocessors. See table 2 for the benchmark results. The listings roughly follow the syntax of the Digital Research DDT86 miniassembler.*

(1a)

```
        MOV     SI,$30
LP1     MOV     DI,$FFFF

LP2     (code to be tested
         placed here)

        DEC     DI
        JNZ     LP2
        DEC     SI
        JNZ     LP1

        (breakpoint set here)
```

(1b)

```
        MOV     SI,$30
LP1     MOV     DI,$FFFF

LP2     XCHG    BX,AX
        XCHG    BX,AX
        XCHG    BX,AX
        XCHG    BX,AX

        DEC     DI
        JNZ     LP2
        DEC     SI
        JNZ     LP1

(breakpoint set here)
```

different for MUL (multiply memory and accumulator). Both 8- and 16-bit arithmetic operations on the 8086 sometimes take the same time, sometimes not. For example, "ADD [30],An" (add either the lower 8 bits of the accumulator, AL, or the entire 16 bits of the accumulator, AX, to memory location 30) takes the same time for both versions, while "ADD An,#1" (add the value 1 to either AL or AX) is about one-third faster in its 8-bit version (see table 2).

Factors That Slow Execution

The relationships between the execution times of the two chips are caused by three factors: the inherent design of the instruction set, the different-sized data paths of the chips, and the mechanics of the prefetch queue. The 8086 instruction set itself (which is identical to the 8088 set) dictates the identical behavior of some of its instructions and not others. The 8088 behavior mimics this when the 16-bit operation is internal to the chip itself (the register-to-register XCHG in figure 1), but not when it deals with external memory and must go through the 8-bit data bus.

The address bus on both chips and the data bus on the 8086 are all 16 bits wide. The data bus on the 8088, however, is 8 bits wide. Although the details are somewhat complicated (both microprocessors use the same pins for both address and data information and so must use external latch chips to separate the address and data information), the result is that the 8086 retrieves or transmits a 16-bit word in one bus cycle, while the 8088 does so in two (8 bits at a time). Consequently, any operation that manipulates external memory will be slowed by the 8088's 8-bit data bus. The extent of the slowdown is determined by the prefetch queue.

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Full technical specifications and prices of LMC's MegaMicros are available on request.

*UNITY is a Trademark of Human Computing Researchers Corp., UNIX is a Trademark of Bell Laboratories

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Listing 2: *Benchmark programs associated with table 2. Listing 2a is an unoptimized bubble sort. Listing 2b is a graphics-scaling routine that does scaling operations on 16-bit pairs of data. Listing 2c does 30,000 floating-point addition operations in BASIC. Listing 2d calculates 5000 square roots and does 5000 multiplication operations in BASIC. The assembly-language listings roughly follow the syntax of the Digital Research DDT86 miniassembler.*

(2a)

```
; Bubble sort
;
; Register BL used as flag, FF hexadecimal means elements switched,
;   00 means no switch
; Register SI points to beginning of list to be sorted
;
        MOV     BL,0$FF         ; flag set to exchange elements
A1      CMP     BL,$FF          ; were any elements exchanged?
        JNZ     A4                          ; if so, done
        XOR     BL,BL           ; set flag to "no switch"
        MOV     CX,0$800                    ; number of elements in list
        DEC     CX
        XOR     SI                          ; set SI to 0--i.e., data is at beginning
                                            ; of data segment
A2      MOV     AX,[SI]         ; compare two adjacent elements
        CMP     AX,2[SI]
        JLE     A3                          ; jump past code for exchanging elements
        XCHG    AX,2[SI]                    ; exchange two elements
        MOV     [SI],AX
        MOV     BL,0$FF         ; set flag to "elements switched"
A3      INC     SI                          ; increment pointer by one word
        INC     SI
        LOOP    A2                          ; pass through table again if CX not zero
        JMP     A1                          ; begin again
A4      NOP                                 ; sort finished
```

(2b)

```
; Graphics scaling routine
;
; Register BX is a counter for an external loop that performs this
;   routine 64 times (40 hexadecimal)
; Register CX contains the number of x,y pairs to be processed
; Register DS = 300 hexadecimal = pointer to data input area
; Register ES = 900 hexadecimal = pointer to data output area
;
; 17FD (hexadecimal) x,y data pairs starting at location 8 are
;   translated to x',y' pairs by the formulas:
;
;                      x'=(21/4)(x-15) and y'=(21/4)(y-8)
;
; The data pairs are all filled to the value (2AAA,2AAA) hexadecimal
; The constants 15, 8, 4, and 21 are in locations 0, 2, 4, and 6,
;   respectively
;
        MOV     BX,0$40         ; set outside loop

LP      MOV     CX,0$17FD                   ; number of data pairs to be translated
        MOV     SI,08           ; address of first x,y pair
        MOV     SI,DI
        CLD                                 ; cleared decimal flag affects LODSW instruction

XY      LODSW                   ; this is DDT86 mnemonic for the word-length
                                            ;  version of the LODS instruction -- this gets
                                            ;  an x value from the list
        SUB     AX,[0]          ; subtract 15
        MUL     WORD [6]                    ; multiply by 21
        DIV     WORD [4]                    ; divide by 4
        STOSW                   ; store as output x value

        LODSW                   ; perform similar functions for y value
        SUB     AX,[2]
        MUL     WORD [6]
        DIV     WORD [4]
        STOSW

        LOOP    XY                          ; loop until CX becomes zero

        DEC     BX                          ; external loop
        JNZ     LP
END     NOP                                 ; end of benchmark -- breakpoint inserted here
```

(2c)

```
10 SIZE=10000
20 VAR1=0
30 ONE=1
40 FOR I=1 TO SIZE
50 VAR1=VAR1+ONE
60 VAR1=VAR1+ONE
70 VAR1=VAR1+ONE
80 NEXT
90 PRINT VAR1; " ADDITIONS DONE"
```

(2d)

```
10 DIM SQRT(5000),NUMSQD(5000)
20 SIZE=5000
30 FOR I=1 TO SIZE
40 SQRT(I)=SQR(I)
50 NUMSQD(I)=SQRT(I)*SQRT(I)
60 NEXT I
70 PRINT SIZE;" ITERATIONS DONE"
```

The Prefetch Queue

To understand the prefetch queue and its role in influencing the performance of the 8086 and the 8088, first look at the internal architecture of the two microprocessors. The 8086 and the 8088 each contain two internal processors, the *execution unit* (EU) and the *bus interface unit* (BIU). The EU executes instructions and depends on the BIU to retrieve and store data and instructions. To surpass the performance of earlier microprocessors that alternated between fetching and executing instructions, Intel decided to include in the 8086 and 8088 a *prefetch queue* that would fetch several instructions beyond the one currently being executed; except for cases in which the current instruction is a jump or branch execution, these fetched instructions are available for execution much faster than if they had to be brought in from memory. The 8086 has a prefetch queue 6 bytes long, while the 8088's is 4 bytes long; in both cases, the bus interface unit is responsible for keeping the queue filled.

(Dan Lenehan, an applications engineer for the microcomputer group at Intel, says the design team determined the optimal size for each microprocessor's prefetch queue by simulating it on a computer. Both the execution unit and the bus interface unit need access to the system bus, but only one can have it at a time. A long prefetch queue needs to be filled more often by the BIU; even though the EU always has priority over the BIU, it must wait for the BIU to release the system bus if its request comes while the BIU is using the bus. Therefore, at a certain length, a long prefetch queue will slow the EU down more than it will help. A short prefetch queue is full more of the time, decreasing the chance that the EU will be slowed by a BIU bus access; however, at a certain length, a short prefetch queue has less "slack" and so saves the EU less time. By simulating each microprocessor's slightly different architecture and the kinds of programs each was expected to run, the Intel designers found a 4-byte queue optimal for the 8088 and a 6-byte queue optimal for the 8086.)

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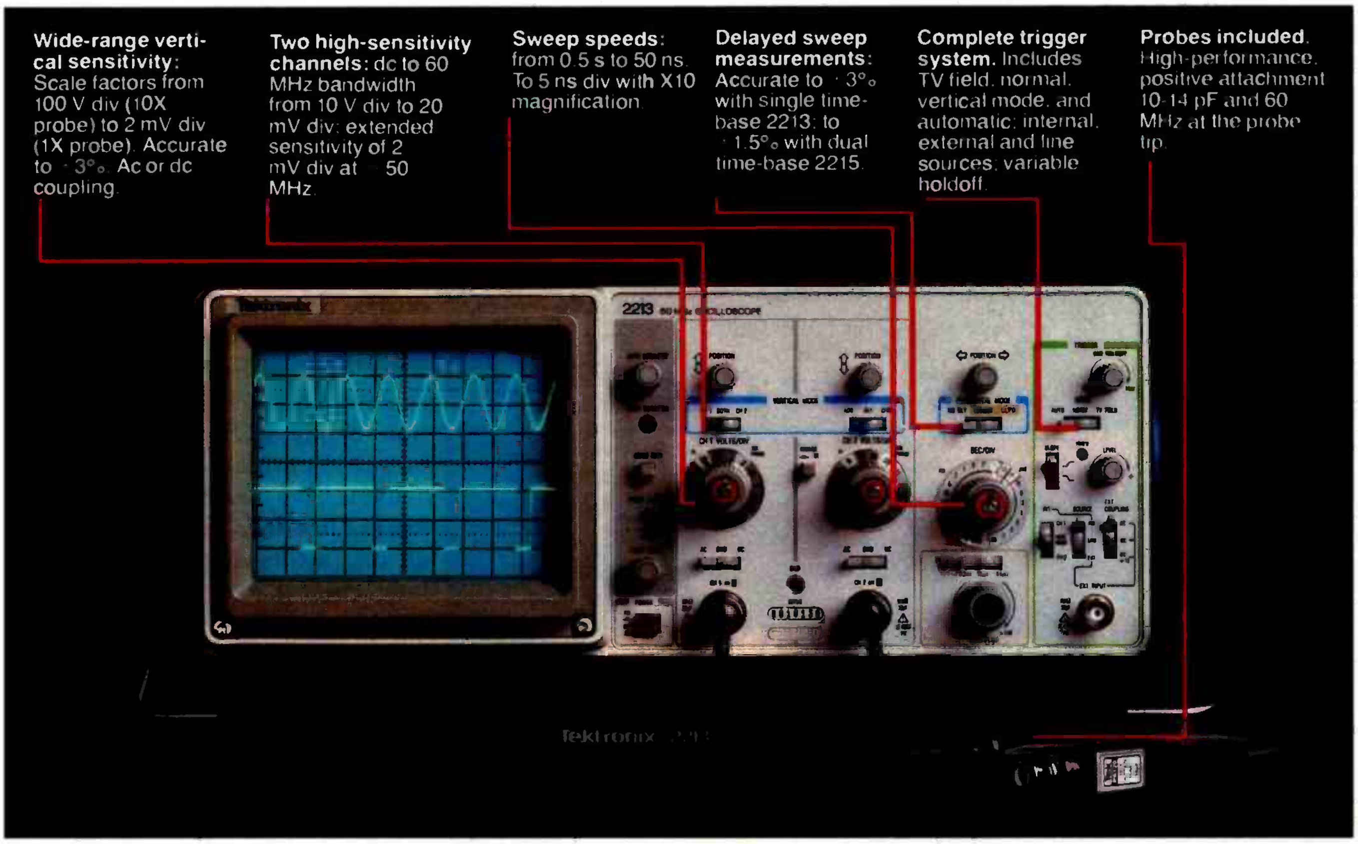

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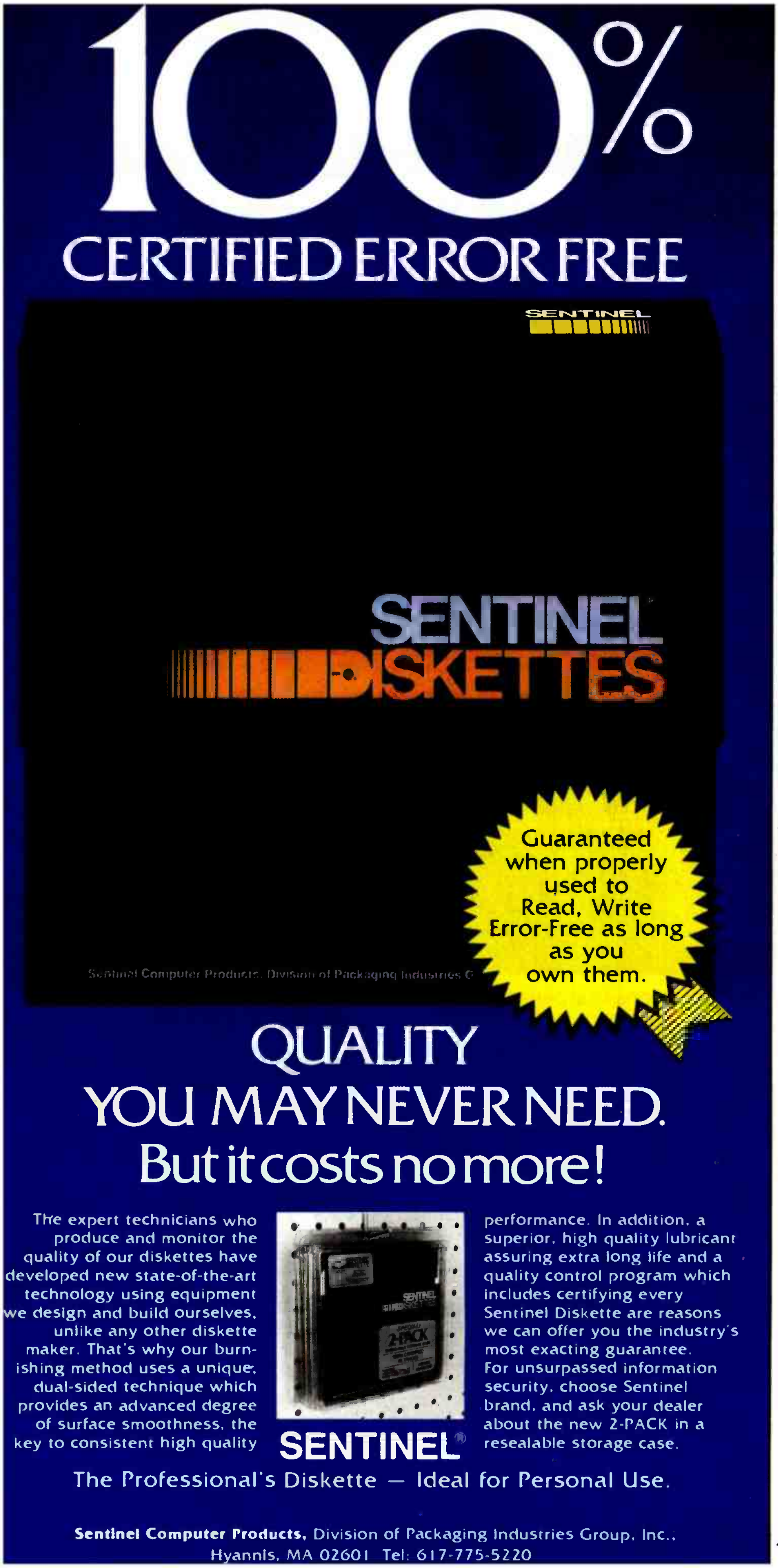

The prefetch queue influences 8086 and 8088 instruction times in two ways. First, longer instructions execute slightly slower on the 8088 because, on occasion, bytes must be fetched directly from memory 8 bits at a time (as opposed to 16 bits in the 8086). This behavior is indicated by the speed of the short JMP (a 2-byte instruction) relative to the near JMP (3 bytes). (See figure 2.) Second, instructions that do more internal processing and leave the system bus free longer allow the BIU more time to fill the prefetch queue uncontested, increasing the speed with which the EU can execute instructions. This explains why the 8088 shows almost no speed degradation for the MUL (multiply) instruction, which spends a lot of time doing the operation internally; some degradation for the ADD instruction, which spends less time in computation; and the most degradation for the MOV (move-register-to-memory) instruction.

(Note: the results in table 2 and figure 1 result from an interaction of all the factors mentioned above, an interaction that varies in proportion from instruction to instruction. For example, the surprising performance of the MUL instruction is probably largely due to the interaction of the EU and the prefetch queue, while that of the MOV instruction is probably due to the 8088's 8-bit data path.)

Finally, the BASIC benchmarks (January 1982, p. 54) indicate that MBASIC-86 version 5.21 (the version we used) will run about 40 percent more slowly on an 8088 when compared with an 8086. For various reasons, the performance of other BASIC interpreters might vary significantly from this, so we should not infer too much about the BASIC language from just one benchmark. However, because Microsoft supplies the PC-BASIC that runs on the IBM Personal Computer and its look-alike machines, it is reasonable to infer that the IBM PC would run BASIC about 40 percent faster if IBM had designed it using an 8086.

Conclusions

After weighing the results of these BYTE benchmarks, should you re-

Chronos Models 500 and 600 (use 80186): Chronos International, 13256 Northrup Way, Suite 7, Bellevue, WA 98005, (206) 641-7277

CPU-286 (S-100 card using 80286, for Compupro 816 system): Compupro, Box 2355, Oakland Airport, CA 94614

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M-20 (uses Zilog Z8001, 8086 coprocessor available): Docutel/Olivetti Inc., 155 White Plains Rd., Tarrytown, NY 10591, (914) 631-8100

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Wang Professional Computer (uses 8086): Wang Laboratories Inc., One Industrial Ave., Lowell, MA 01851, (617) 459-5000

Table 3: *A list of selected vendors of computers that use the Intel 8086, 80186, or 80286 microprocessors.*

think your inclination to buy an 8088-based computer? Possibly, but not necessarily. If the choice is between the 8086 and the 8088, the two are identical except for the speed difference. And execution speed, though a seductive factor, is not the only criterion that should influence your selection of a microcomputer. You should also consider price differences, ease of use, software and hardware compatibility (especially with the IBM PC and its associated operating systems—Microsoft's MS-DOS, Digital Research's CP/M-86, and Softech Microsystems' p-system), features, and other factors. Table 3 lists manufacturers who offer 8086-based computers, all of which claim various levels of compatibility with the IBM PC. Two of those listed use an Intel 80186, and a third offers an S-100 board that uses an Intel 80286; both are next-generation chips that are upward compatible with the 8086.

Bill Skelton of Texas Instruments points out that the gestation time of a product is usually between 18 and 36 months. This time frame has two implications. First, because of the lead time and the IBM PC's popularity, many computers introduced in the next few years (which have been fully designed by now) will use the 8088. However, look for some brave manufacturers to use the Intel 8068, 80186, or 80286 microprocessors, sacrifice hardware compatibility with the IBM PC, but maintain software compatibility. Second, look for designers to switch to other chips eventually—the advanced Intel chips (including a 32-bit 80386 that is also upward compatible with the 8086) or even to other microprocessor lines, e.g., Motorola's MC68000, Zilog's Z8000, or National Semiconductor's NS 16032. ■

About the Author

Gregg Williams is senior technical editor of BYTE.

Acknowledgments

We thank Compupro (Box 2355, Oakland Airport, CA 94614) and Lomas Data Products (66 Hopkinton Rd., Westborough, MA 01581) for their help on this article.

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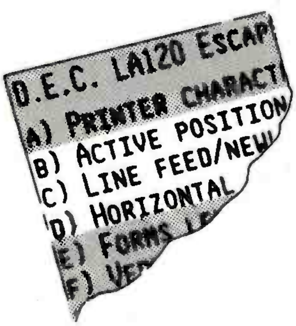

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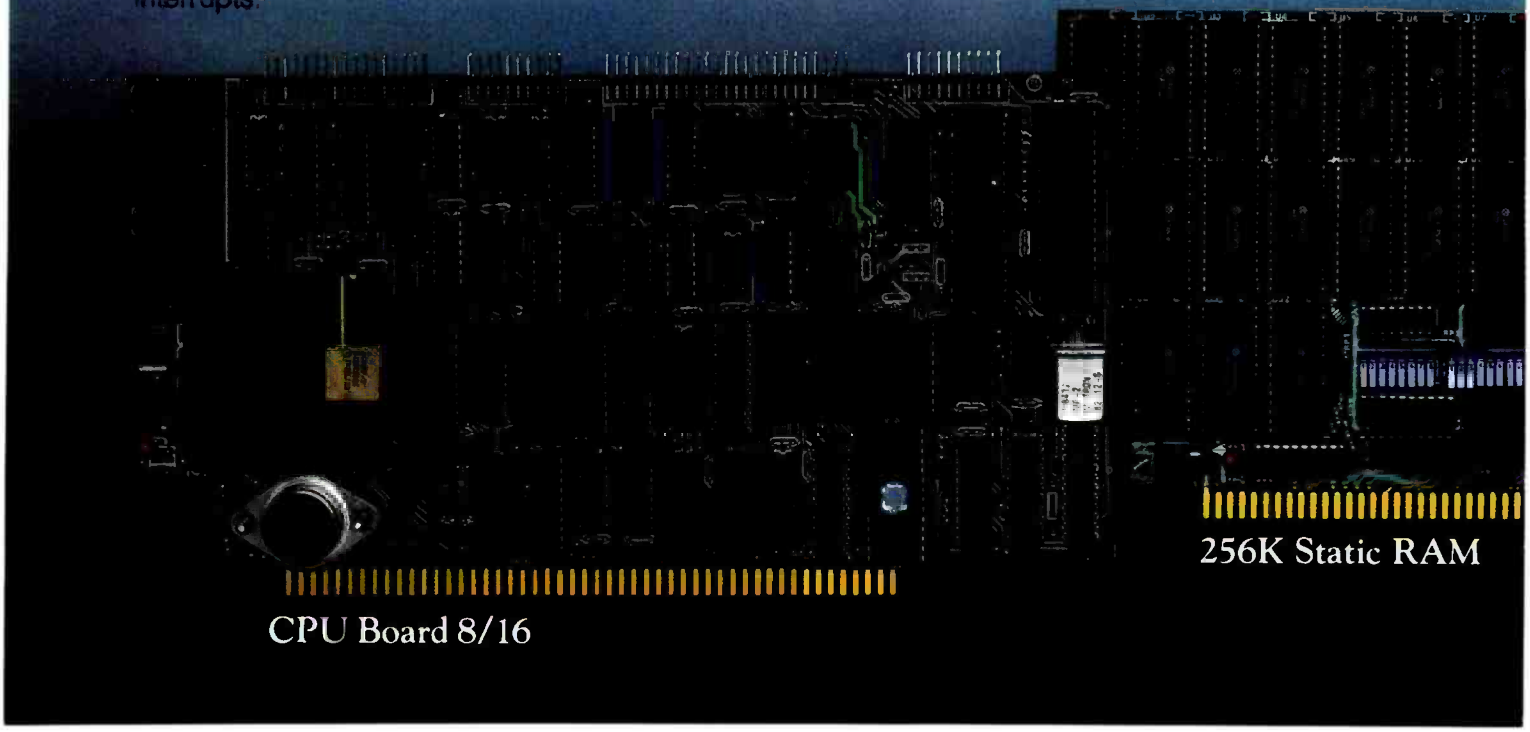

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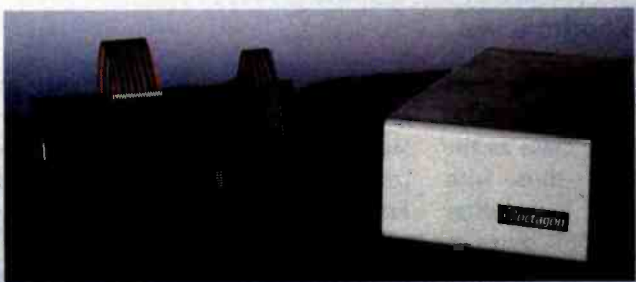

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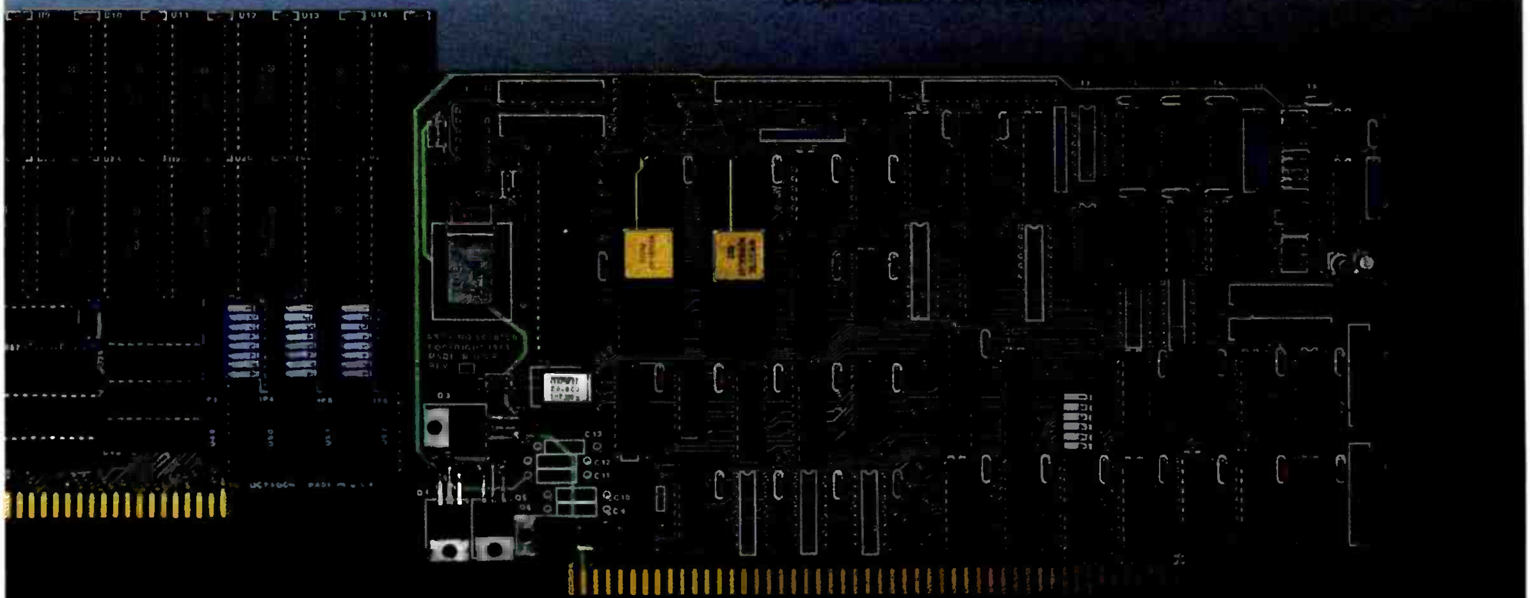

Hard Disk Controller

Visi On's Interface Design

by Dr. George Woodmansee

Visi On belongs to a new breed of office automation software that makes it possible for diverse application programs to interact. Instead of switching from one application program to the next, users can run several programs simultaneously and transfer data directly between them. Initially, Visi On's open-ended system will accommodate spreadsheet, word processing, plotting, data manipulation, and communications software. Because it makes use of windows to implement the "desktop metaphor," Visi On appeals to a wide variety of business users. (See "A Guided Tour of Visi On," June BYTE, page 256, for a more detailed description.)

As system architects of Visi On, the major challenge we faced was to design a user interface that integrates varied applications and hides their differences while maintaining their power and potential to work together. After discussing the philosophy behind Visi On's design, we'll take a look at the factors that shaped it and how our design team met its challenge.

Project Goals

Visicorp's Visi On project is an effort to produce an efficient and businesslike office-automation product using the most appropriate software and hardware technology. The first release, scheduled for late summer, is for machines in the same class as the IBM Personal Computer—those with bit-mapped displays, a Winchester hard disk, and at least 256K bytes of memory.

Our primary goal was to produce a nonintrusive problem-solving support system for the office professional: a workbench and tools that do the job without getting in the way. We wanted to design a system that integrates application packages by making data interchange simple and provides the appearance of concurrent application execution. We wanted it to be easy for a novice, casual user, or experienced user to learn. Finally, we wanted the system to be able to accommodate new and unanticipated applications.

Design Factors

Two major factors shaped Visi On's design: the needs of the end user we had in mind and relevant available technology.

The market for Visi On is primarily office professionals, a varied group that includes middle and upper managers in large businesses, small businessmen, staff analysts, and planners. Time, pressure, and the need for quality results are critical to this group.

To be productive, efficient, and successful at their work, office professionals look for an office-automation product that fills three major needs. First, the product must help solve problems quickly without getting in the way. Second, it must enable users to gain expertise easily and make allowances for different levels of facility. Office professionals are casual users who may be experts in some parts of the system and novices in others. They are neither computerphiles nor touch-typists. Finally, the product must support different styles of problem solving. People vary widely in the way they solve problems; some may carefully plan and execute an attack, while others will indulge in a series of skirmishes until the problem is solved.

After identifying our target audience, we considered three communication concepts: representation, direction, and presentation.

Representation

A well-chosen and consistently applied metaphor is a key to successful interface design. By mirroring the behavior of systems that are already familiar to the user, a valid metaphor enables the user to correctly anticipate the operation of the system. Because the Visi On system must support concurrent operation of applica-

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tions that manipulate objects familiar to the office scene, the interface design is based on the desktop metaphor. This representation identifies the user's desk with the screen and, correspondingly, objects that might appear on the desk with objects on the screen.

Direction

The way in which the user directs the system should complement the metaphor and the user. Because the user is assumed to be casual and not a touch-typist, the design emphasizes recognition rather than recall. Thus menu selection was favored over command entry and pointing over keystroking.

Presentation

For the desktop metaphor to work effectively, users must have the feeling that the electronic objects are real. In other words, when objects are manipulated, they must behave in a manner analogous to the behavior of their physical counterparts. Part of this mimicry calls for the use of raster graphics in order to maintain objects lying about the screen.

The Design

Having defined our project goals and identified the audience and the technology available, we developed and carefully considered at least four contending design models. These included a Smalltalk-like model (object oriented, multiwindow), a Star-like model incorporating the desktop metaphor, an overlapped 4-window model, and an overlapped 2-window model. Because these models did not meet the project goals, they yielded to the current design, which is a variant of the desktop metaphor.

The Visi On design is menu driven, uses a mouse to select commands and some arguments, uses a verb-object rather than object-verb syntax ("delete text" rather than "text delete"), and supports a variable number of applications communicating with the user through individual, possibly overlapping windows. Because the design focuses on applications running in windows, the interface is application oriented as op-

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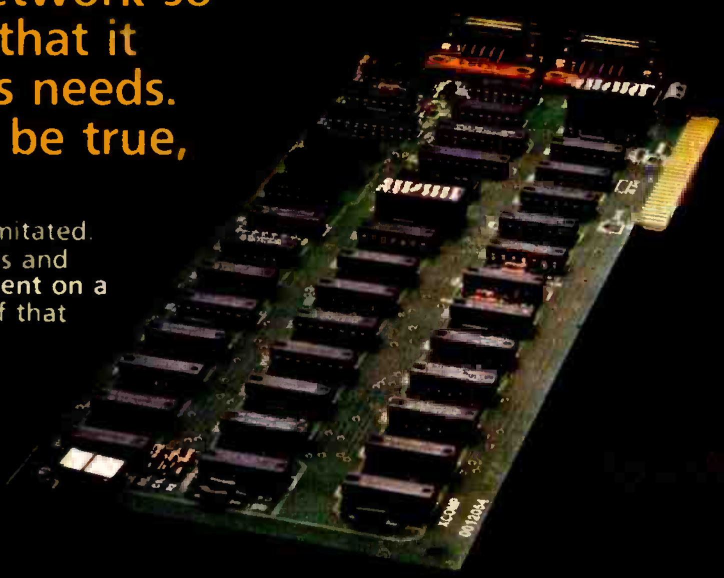

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posed to object oriented. Thus the objects on the user's desk are applications operating on spreadsheets, documents, graphics, and the like, rather than the spreadsheets, documents, or graphs themselves. (The underlying system design, however, is object oriented.)

We rejected the Smalltalk and Star-like interface models primarily because they were object-oriented designs that made heavy use of icons. While both of these approaches have many desirable properties, our need to provide an environment that would allow fast and easy introduction of new applications and the relatively limited resolution of the targeted class of machines argued against their use. Whether the business market will accept icons is also unclear.

Our choice of a verb-object rather than object-verb syntax was based on the (unsubstantiated) hypothesis that users verbalize in this fashion ("fire Phil" rather than "Phil fire") and consequently would tend to find it more natural. The marketplace will ultimately determine which, if either, is preferable.

We rejected the 2- and 4-window models, while conceptually simple, because they severely restricted the number of applications users could concurrently manipulate.

Two Important Design Concepts

The conceptual framework supporting the Visi On interface is the result of sifting and synthesizing ideas from many sources. Two areas in particular, application structuring and the help network, illustrate the thinking behind the interface.

The Visi On system and applications together must help novices and expert users alike. How should the behavior of individual applications be structured to support both groups?

Application behavior is what users experience when they interact with an application. Does it act predictably? Is the user in control? Is it clear what to do next? The correct answers to these and similar questions determine the effectiveness of the application as a tool in the user's hands. The behavior of an application mirrors its

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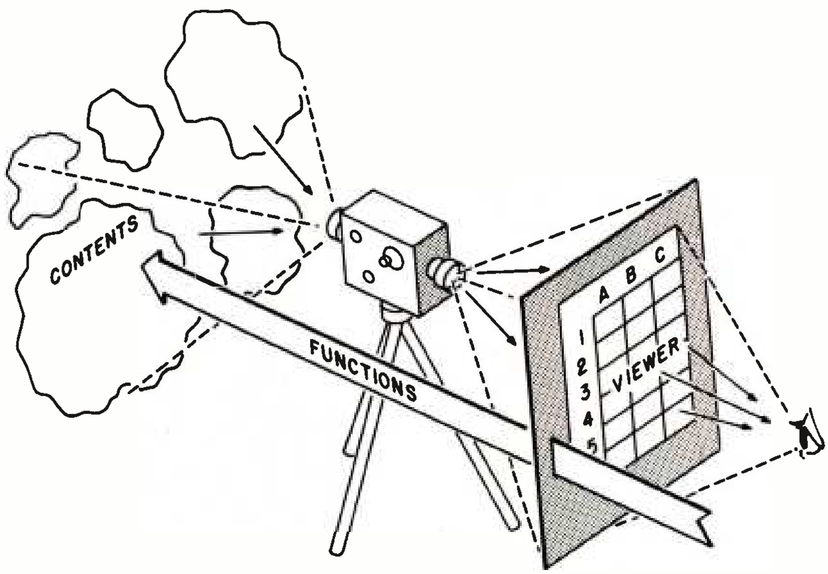

Figure 1: *A general Visi On applications model.*

internal structure, so application structure is important in determining behavior.

One goal of systematizing the structure of an application is to provide similar behavior in similar circumstances, to give the user a sense of familiarity. All menus, for example, look similar and work the same way. Another goal is to break the application into comprehensible pieces that are closely related to the way a user attacks problems (that is where I do my editing, this is where I do my analysis, this is where I do my plotting). A third is to provide a framework in which to state uniform interface guidelines.

By designing applications and their parts to look and feel alike and by breaking them into digestible pieces, it takes less effort for a new user to learn an application and less time for a semi-experienced user to add another application to his repertoire. Moreover, the casual user obtains reinforcement applicable to all applications each time he uses any one.

The Application Model: Parts

We used the application model illustrated in figure 1 to provide a conceptual framework for dealing with application behavior. In this model, an application consists of contents (spreadsheet, graph, document, and so on), characteristic views of contents (one aspect of total screen appearance), and functions that the user can invoke to change the contents or the way they are viewed. A spreadsheet application would be modeled as follows: the contents would consist of one or more spreadsheets, the characteristic views would be windows onto the sheets, and the functions would include content manipulators such as Insert Row, Recalculate, and Enter Formula and view manipulators such as Scroll and Freeze Border.

The Application Model: Places

From the user's point of view, an application is a tool that helps solve a class of problems by providing a specific capability. This capability often breaks naturally into several subcapabilities that suggest a top-level structure for the application. For example, a stand-alone application like the Visitrend/plot program might be described as helping a user to solve graphical problems. Generally, solving these problems requires that the user be able to manage, edit, plot, and analyze data. This suggests what the application structure should be.

The application model captures subcapabilities by using the concept of places. Each place is a group of functions with its own characteristic display. At present, functions are organized into a static hierarchy and

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if properly constructed should satisfy these requirements:

- The user, even the first-time user, should intuitively know the kinds of things that can be done at a given place. If the place supports editing, the user should expect something like an Insert function and should not be surprised to discover a Delete function.
- Equally important, the user should intuitively know what cannot be done at a place and where the place is to do it.
- Because a place corresponds to a major step in the solution of a problem, the user should not need to shift frequently from place to place. If shifting is required, the place is not well conceived and should be reformulated because such shifting distracts the user from the problem being solved.
- Places should have associated characteristic displays so that the user always knows his location.

Places are organized into a small, static hierarchy and are named to reflect that. This aids the user in navigating in search of subproblem support not available at the current place.

Movement from place to place is always the result of an explicit user request. This provides a feeling of stability and predictability.

A place provides a palette of functions for the user and remains in a neutral state until he chooses one or moves to another place. While in the neutral state, the place exhibits neutral-state behavior. Neutral-state behavior is generally application and place dependent but will usually involve direct manipulation of the contents through the characteristic display. For example, in a word processor, neutral-state behavior would support repositioning the character cursor with the mouse and typing into the document.

All functions have a predictable behavior called the function-action cycle (see figure 2). Stereotyping function behavior provides a framework for specifying when and where user feedback is supplied. The function-action cycle begins when the

Text continued on page 178

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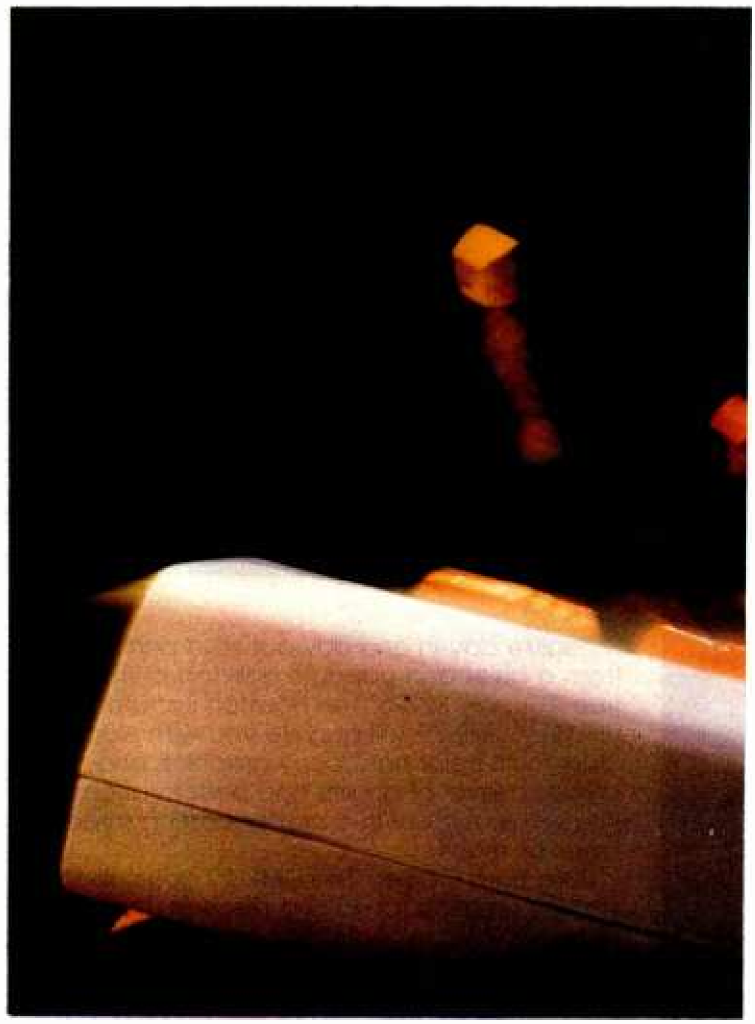

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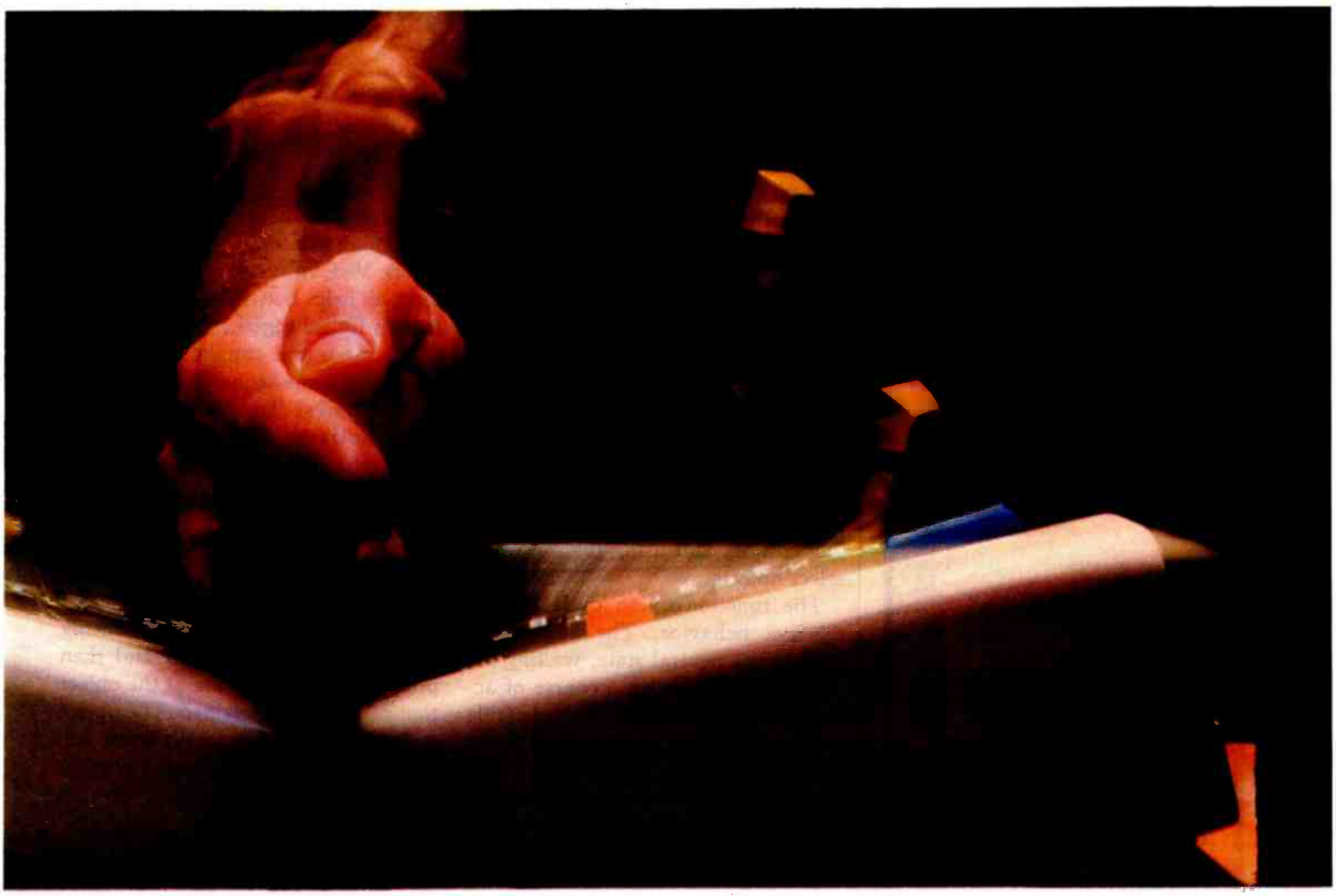

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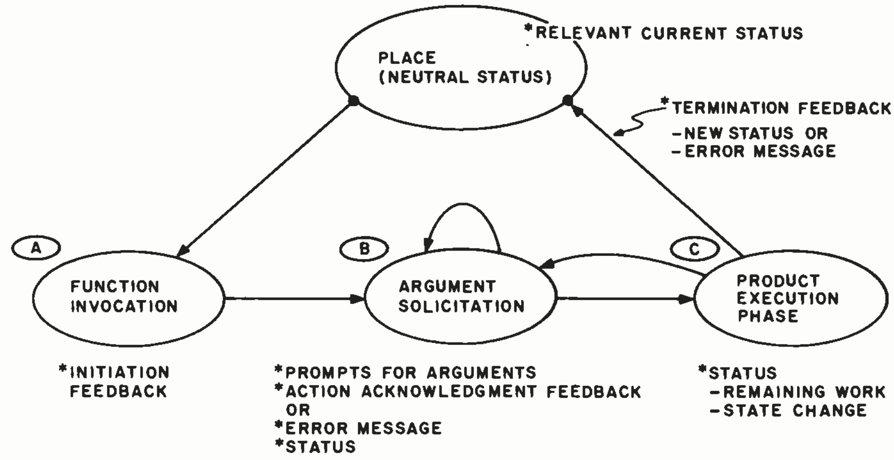

Figure 2: *The function-action cycle.*

user picks a function, providing zero or more arguments and an execution phase in which the requested function is performed. Function-action cycles always terminate in the neutral state.

Applications implement the argument-solicitation phase by using a small number of canned I/O (input/output) primitives called BITS (basic interaction techniques). This is one of the mechanisms employed to achieve uniform behavior. BITS support such things as multiple choice, line editing, and using the mouse to select objects.

The function-action cycle models reactive behavior. The application idles in the neutral state, waiting for the user to decide on a course of action, and then reacts in a predictable manner by jogging his memory for necessary actions (prompting), informing him of the continuing state of affairs (status), acknowledging his actions (sound and selection feedback), producing what was expected (status) or informing him why the result could not be produced, and ideally suggesting corrective action (error messages).

Guiding the User

The system must accommodate users who are not quite sure what to do next as well as those who have reached an impasse.

Users need help when they don't understand some aspect of the system or application. They may be confused about the capabilities of an application, unclear prompts or error messages, or how to accomplish a particular task.

The Visi On system provides an extensive help network of individual frames linked together in such a way that any frame can be reached by following some sequence of interconnecting links. The more links that must be traversed, the farther apart the frames. Related frames are "near" in this sense; loosely related frames are farther apart. The Visi On help system interface provides a natural means of moving from frame to frame.

A user requests help by choosing HELP in the global menu and then pointing with the mouse at the object that needs to be explained. The object may be a menu choice in some application, an error message, a portion of a display, or anything on the screen that may require explanation.

The help system responds by opening a new help window and displaying the appropriate help frame. Once the window is open, the user is free to traverse the help network by picking commands in the help window's menu or cross-references that may be embedded in the help text itself. Help windows behave just as any other application in the system and thus may be reframed, closed, or opened completely to fill the entire screen. Useful frames may be placed off to the side for frequent reference, tucked away for future reference by closing, or deleted.

The help network mechanism is so general that it is quite possible to design networks that hinder rather than help the user. To design an effective network, it is important to understand the various conditions that prompt users to solicit help.

The user who solicits help is generally in trouble. Thus help is a necessary distraction that will be tolerated to a greater or lesser degree depending on the nature of the problem the user is solving. If the problem is "getting to know the system better," a spare-time activity, perhaps, the user will be willing to interact extensively with the help facility. On the other hand, if the problem is "getting the report out in the next half hour," the user's tolerance for help distractions will be low. In the first example, the user is essentially nondirected, a browser with no specific goal. In the second, he has a very specific goal.

Browsers do not have a sense of urgency and are willing to travel around the help system as their interests dictate. They require overview frames to orient themselves and detail frames to dig deeper into interesting areas, and they frequently use glossaries and references to indirectly related help materials.

Goal-directed users, in contrast, do have a sense of urgency, perhaps made acute by a deadline. They are put off by verbosity, involved nonfocused traveling, and expositions that don't seem to be leading them quickly to a better understanding of how to use the system to solve a problem.

The design and organization of help frames depend upon whether a user is browsing or in hot pursuit of a solution to a specific problem. To the extent that designers can anticipate this, the network may be tailored. An individual help frame catering to a browser might be almost tutorial in nature and look like a page out of a manual. Such a frame would be text intensive and have little white space. A frame supporting a directed user will look more like a viewgraph, with ample white space and a regular layout.

Goal-directed users enter a help

frame thinking of their problem in terms of solution steps natural to them. They should emerge with potentially relevant actions directly supported by the application. These help frames serve to translate user subproblems into application actions. This implies that the frame should allow the user to quickly answer the following questions:

•Ballpark: Is this frame relavant? (Am I wasting my time reading it?)
•Target: Assuming it's relevant, where is the information I need?
•Action: Assuming I've found the information, what do I do next?

Assuming that users read text from left to right and top to bottom but can quickly scan text vertically if it is organized in a regular, visually predictable manner, we are led to frames that have a tabular layout. This layout presents user concepts vertically on the left in frequency-of-use priority (if that is known or applicable) so that users can quickly answer the targetting question. Corresponding actions or further helps appear on the right, allowing the user to answer the action question. The purpose of the frame should be explicitly stated so that the user may quickly answer the ballpark question.

Conclusion

The concepts and structures underlying the Visi On interface are a synthesis of ideas from many sources, some theoretical, some applied, some tested, some previously untried. There are few proven methods in this technology, for this audience, and with our express goals. Based on our research and tests with sample users, we believe that Visi On will be all that we set out to achieve. The real test, though, will be in the marketplace with end users who are looking for a practical tool that gets the job done without getting in the way. We await their verdict. ■

About the Author

Dr. Woodmansee is a staff engineer at Visicorp Inc. (2895 Zanker Rd., San Jose, CA 95134). He is responsible for the development and application of applied human-engineering technology.

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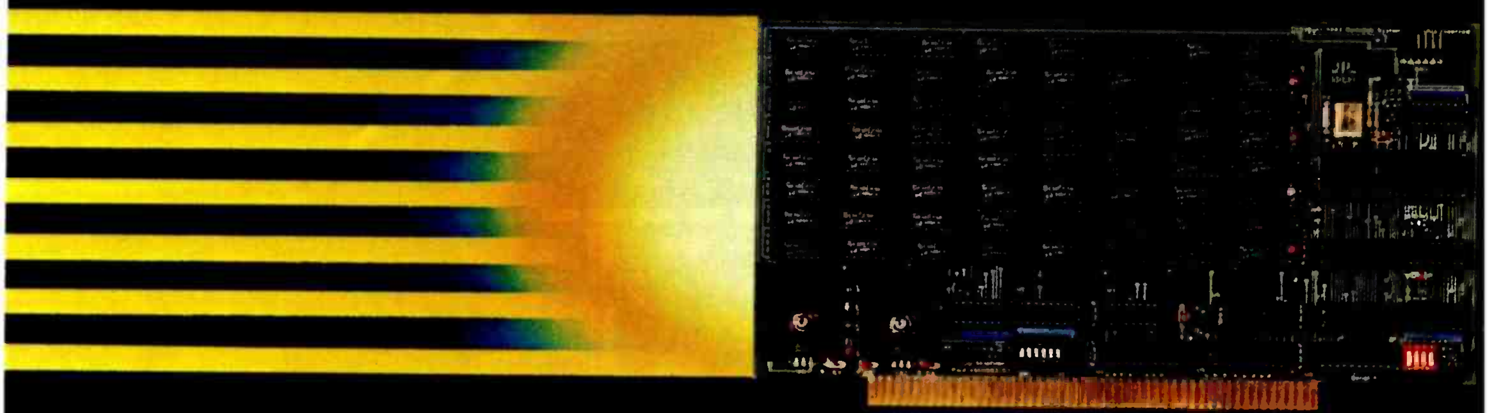

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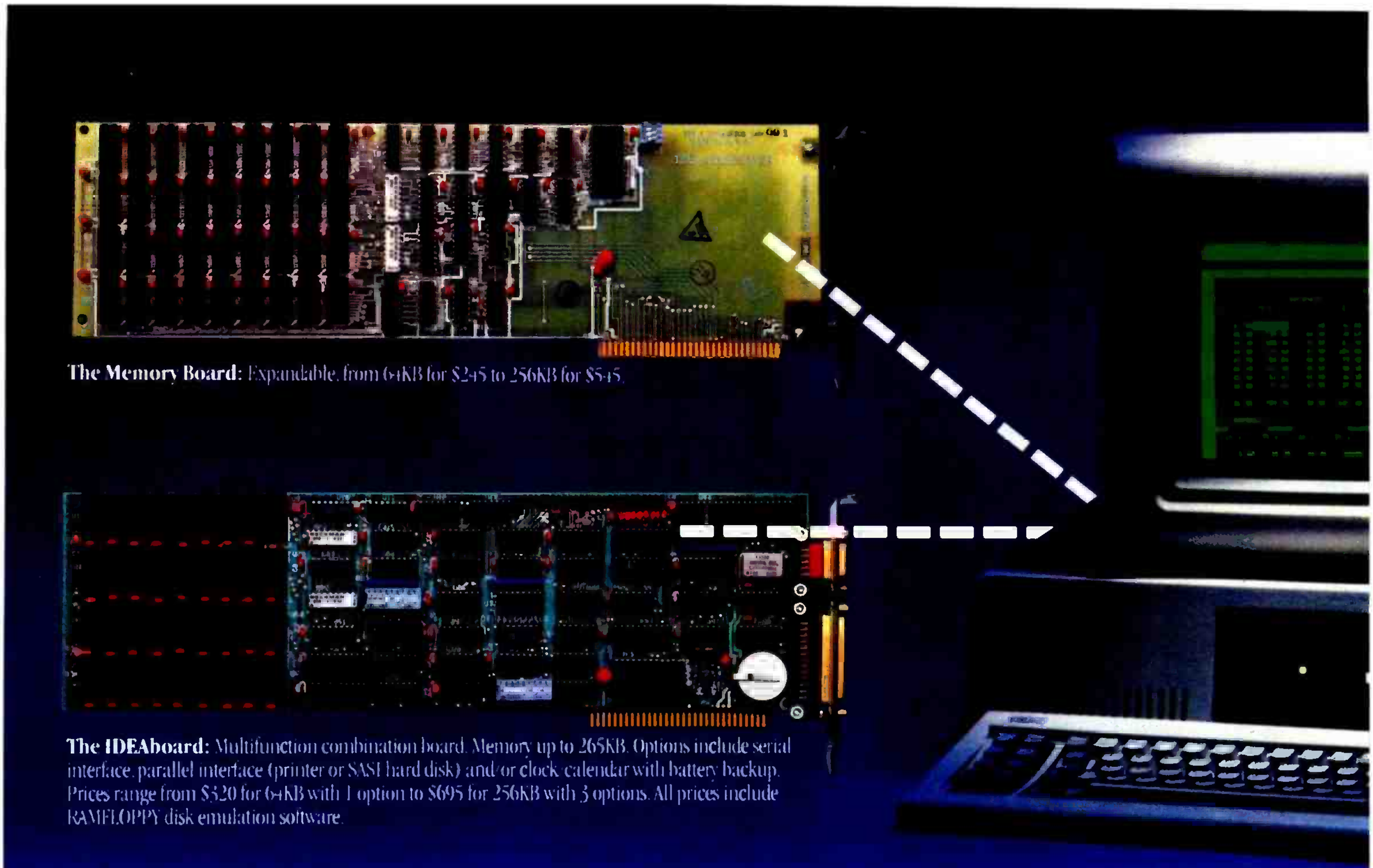

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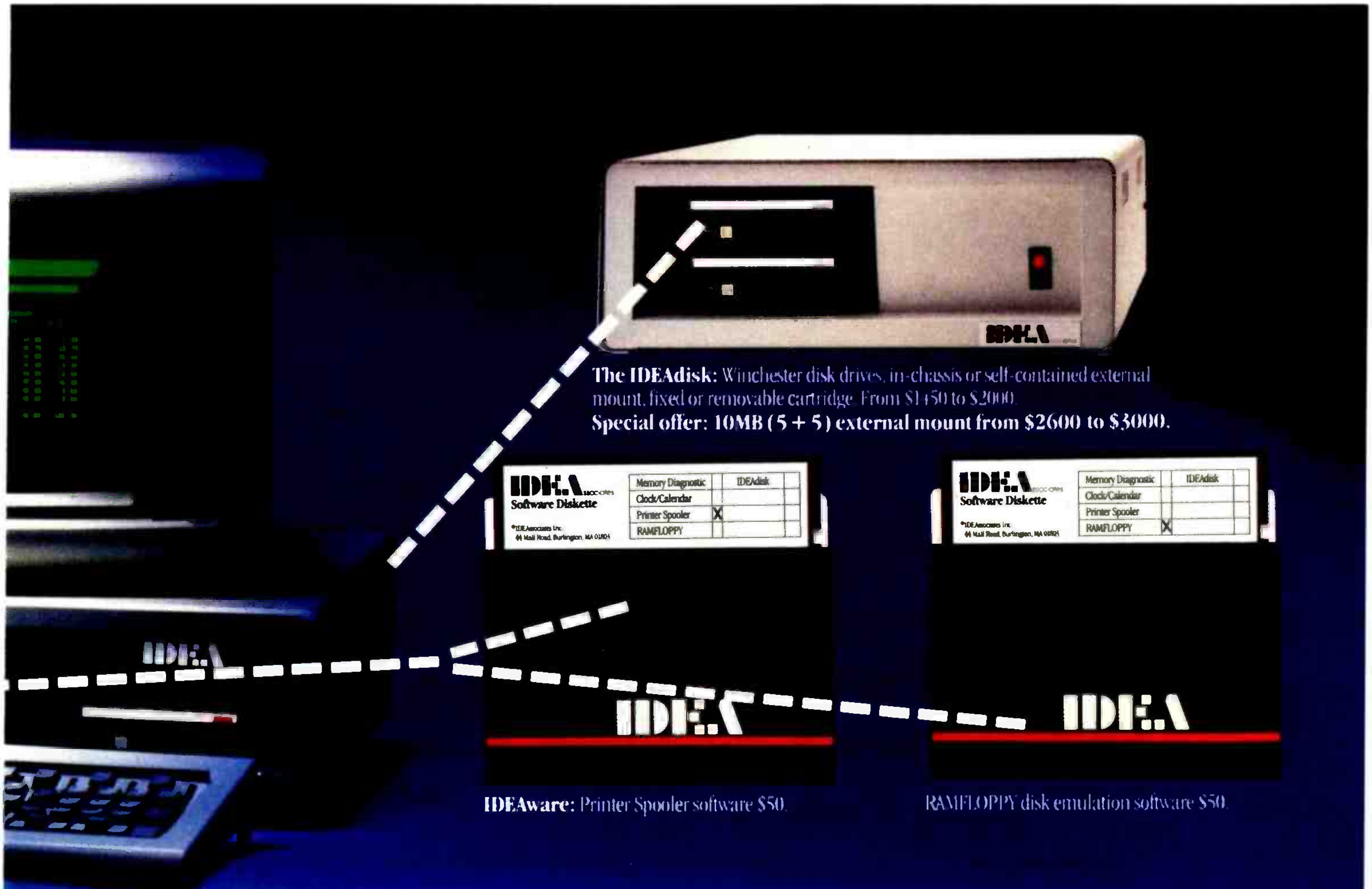

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Voice Lab

Part 1: A System for Digital Speech Synthesis and Analysis

Several modular routines are useful for application programming and experimentation.

by John E. Hoot

Your new home video game rasps playing instructions to you when you make a mistake. Your new car audibly reminds you to buckle your seat belt and check the oil. And in your office building, the elevator politely announces its arrival at your floor.

Digital speech synthesis has made it possible for commonplace mechanisms to possess surprising powers of expression, and advancing technology is making speech synthesis practical at lower and lower prices. Machine recognition of speech is progressing much more slowly, but it is making a first appearance in a few applications where it's cost-effective.

Speech synthesis has also shown up in personal computers, but the synthesis schemes in common use have limitations (in expense, vocabulary, or intelligibility) that have restricted their use. However, any personal computer equipped an analog-to-digital (A/D) converter and a digital-to-analog (D/A) converter would theoretically be capable of both speech synthesis and recognition, if only it had the necessary software.

A practical, reliable, and affordable method for computers to recognize and synthesize speech would yield at least these three benefits to computer users:

Maximum user-friendliness: Speech is our most natural mode of communication.

Economy: Speech interaction could eventually become the least expensive way to communicate with a computer. The components of today's most common user/computer interface—a video monitor and keyboard—cost several hundred dollars, while a loudspeaker and microphone cost only a few dollars. Given the decreasing price of electronic sophistication, a future generation of portable computers may be speech-oriented.

New applications: Speech interaction does not interfere with most human activities, especially those that require use of the hands; therefore, speech interaction could allow computers to be used for tasks that are now impractical.

But despite the potential benefits of computer speech, the problems it poses are not simple.

Most personal computer systems can now be equipped with analog-to-digital and digital-to-analog converters. The A/D converter allows the computer to detect the continuously varying electrical signals that represent (form an analog of) a sound and store them as a series of binary numbers. Conversely, the D/A converter takes a series of numbers stored in the computer and produces analog electrical signals, which can be fed into a loudspeaker to produce sound. Numerous articles have been written by other authors to explain how these devices work and how to add them to your computer, so I won't treat them in any detail here (see references 2 and 8).

Nevertheless, programs to use A/D

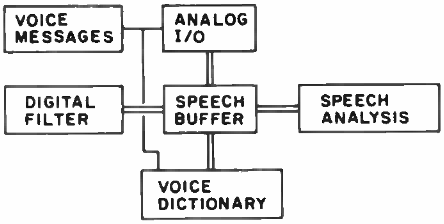

Figure 1: *The main program, Voice Lab, uses a set of p-System units that aid in the creation and maintenance of a vocabulary and provide signal-analysis and signal-modification functions to investigate the structure and content of digitized speech. The program units are designed so that they not only serve Voice Lab but can provide synthesized speech output from virtually any program running under the p-System. Data flows between the units according to a fixed scheme.*

Analog I/O Unit
- services provided:
  - analog output from the speech buffer
  - digitizing speech into the speech buffer
- resources provided:
  - 16K-byte speech buffer
  - tempo-rate variable

Voice Dictionary Unit
- services provided:
  - vocabulary word look-up
  - vocabulary word insertion
  - vocabulary word deletion
  - vocabulary word retrieval
  - dictionary erasure

Voice Messages Unit
- services provided:
  - word-to-speech output
  - string-to-speech output

Voice Display Unit
- services provided:
  - zero-crossing counts and plots
  - spectral-energy plots
  - total speech-energy plots
  - signal-level monitoring

Voice Filter Unit
- service provided:
  - interactive linear digital filtering

Table 1: *Summary of functions of Voice Lab units.*

and D/A converters for speech interaction or even for mere speech research are lacking for most computers. For my own purposes, I set out to design an integrated, yet modular, system of hardware and software that would do two things: allow me to use my present application programs with speech output and permit me to perform speech analysis to study the potential for speech input.

The result of this effort is a collection of specialized program routines that are compiled as Pascal-language units in the UCSD (University of California, San Diego) p-System, which is supported by Softech Microsystems. These program units are used by a main program called Voice Lab, working together according to the relationship shown in the block diagram of figure 1.

(In UCSD Pascal, a unit is a collection of specialized procedures and/or functions that can be used as if they were explicitly declared within the program that uses them. Preprogrammed units, tailored to an application, extend the utility of the UCSD Pascal language without requiring that the language itself be extended. Units are usually compiled separately from the using program.)

Voice Lab serves as an interactive utility program, aiding in the creation and maintenance of a vocabulary and providing signal-analysis and modification functions to investigate the structure and content of digitized speech. Furthermore, the program units are designed so that they can not only serve Voice Lab but also provide synthesized-speech output from virtually any program running under the p-System. They allow my computer to speak with a limited vocabulary and provide a set of tools for investigating computer speech-generation and recognition.

Architecture of Voice Lab

Each function of Voice Lab is provided by a single unit; each unit contains all of the variables and structures necessary to provide its particular service. The interface sections of each unit contain only these necessary structures. Table 1 summarizes the services and resources provided by each unit in Voice Lab.

This design approach has several benefits. It's easy to change the way functions within Voice Lab are implemented. Recompilation time is minimized. Because units are always segmented, the program can be made more complex without increasing memory requirements; and the Voice Lab units can be easily reused in other projects.

Let's take a look at the individual units and their functions.

Analog I/O Unit

The Analog I/O (Analog_IO) unit of Voice Lab uses the computer's A/D converter to record snatches of sound, initially held in a sound buffer, as a sequence of numbers. The unit also performs the opposite function: it converts a sequence of numbers in the sound buffer into audible sounds using the D/A converter. These two processes are called *speech encoding* and *decoding*.

Of the units in Voice Lab, only the Analog I/O unit and the speech-analysis units are concerned with exactly how the speech sounds are encoded in the buffer. You can encode sounds in many ways, and different methods are appropriate in different applications.

Two principles are important in choosing an encoding scheme. First, the more you know about a sound before you start encoding it, the more compact you can make your encoding. Second, you should weigh computational complexity (encoding and decoding time) against the space required to store the sound.

To decide on how to represent sounds as numbers, I began by applying the first principle.

Speech is much like music played from a complex instrument. It is composed of many different "notes" played simultaneously, interacting in complex ways. Furthermore, the voice is a tremendously versatile instrument. It can be as percussive as a snare drum at one moment or as melodious as a flute just a fraction of a second later.

The frequencies present in speech can range from 15 kilohertz (kHz) down to 10 hertz. And the signal-strength range of the human voice is as impressive as its frequency range. The ratio in volume between a shout and a quiet whisper is over 16,000 to 1. To detect every nuance of all the sounds in a voice, you would have to measure the sound signal over 30,000 times per second and store each measurement, using many bits of the computer's memory. Exactly capturing 1 second of such speech with certainty would require more user memory than my computer contains. Even a floppy disk would hold only 4 to 5 seconds of sound, and the data-transfer rate could not keep up.

Fortunately, it isn't necessary to reproduce speech sounds with that much precision for them to be acceptable and understandable. Voice telephone systems, for instance, are restricted to transmitting voice sounds from 30 Hz to 3 kHz, with volume ratios of less than 1000 to 1. True, people's voices do not sound the same on the phone as in person, but it's usually easy to recognize a familiar voice over the phone, and the speech is easily understood.

What constitutes acceptable speech


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Sample Time	PCM Wave	DPCM Wave	DPCM Delta	DPCM Error	ADPCM Wave	ADPCM Sign	ADPCM Delta	ADPCM Error
1	100	100	0	0	100	1	4	0
2	160	160	32	U	108	1	8	52
3	192	192	16	0	124	1	16	68
4	208	208	−28	0	156	1	32	52
5	180	180	−63	0	220	1	64	−40
6	71	117	−63	−46	92	−1	128	−21
7	27	54	−31	−27	28	−1	64	−1
8	23	23	37	0	−100	−1	128	123
9	60	60	63	0	156	1	256	−96
10	181	123	63	58	284	1	128	−103
11	210	186	21	24	28	−1	256	182
12	207	207	−27	0	156	1	128	51
13	180	180	−61	0	220	1	64	−40
14	119	119	−49	0	92	−1	128	27
15	70	70	−12	0	28	−1	64	42
16	58	58	−19	0	156	1	128	−98
17	39	39	−11	0	92	−1	64	−53
18	28	28	11	0	60	−1	32	−32
19	39	39	24	0	−4	−1	64	43
20	63	63	60	0	124	1	128	−61
21	123	123	54	0	60	−1	64	63
22	177	177	23	0	92	1	32	85
23	200	200	−2	0	108	1	16	92
24	198	198	−17	0	140	1	32	58
25	181	181	−62	0	204	1	64	−23
26	119	119	−19	0	76	−1	128	43
27	100	100	0	0	140	1	64	−40

Table 2: *Comparison of time-domain speech encodings. The "Wave" columns refer to the values of the reproduced waveforms.*

quality is a subjective judgment on the part of the listener. One factor I had to consider when picking a frequency range for Voice Lab is the voice pitch of the human speakers likely to be speaking into it. A low-pitched voice would need fewer samples than a high-pitched one. If you want to use Voice Lab, you should experiment with different sampling values. I have been satisfied with limiting Voice Lab to speech sounds from 50 Hz to 2.5 kHz, with volume ratios of less than 256 to 1.

As I have constructed it, the Analog I/O unit encodes speech by sampling the input sound signal 5000 times every second and converting its amplitude into a number from 0 to 255. A burst of speech is represented in Analog I/O as a vector of these samples. The exact method of converting the sound to numbers will be discussed shortly. However they are encoded, the numbers are translated back to a sound wave when Analog I/O writes out successive samples each 1/5000 second to a D/A converter and thence through an audio amplifier and into a loudspeaker. A 16K-byte speech buffer will hold about 3 seconds of speech; depending on how quickly you speak and on what you say, this is between 3 and 10 words.

Methods for encoding speech fall into two broad categories: frequency-domain and time-domain approaches.

Time-Domain Encoding

Time-domain encoding methods seek to measure and record the amplitudes of the sound waveforms, which vary in time, and to reconstruct the speech waveforms from their recorded history. The three most popular techniques of time-domain encoding are pulse-code modulation (PCM), differential pulse-code modulation (DPCM), and adaptive differential pulse-code modulation (ADPCM). All of these measure the exact amplitude of the speech waveform frequently enough so that when it is played back a reasonable facsimile of the original wave results. Table 2 shows a comparison of the encodings produced by the three methods.

The method of encoding speech I chose is *pulse-code modulation*. This technique requires no special knowledge about speech signals, except their bandwidth. It uses the most memory for a given amount of signal of the three techniques mentioned, but it is the simplest. In fact, virtually no computing at all is required beyond the storage and retrieval of the data. A speech sample before encoding by PCM is shown in figure 2a, while figure 2b shows the sample afterward.

The other methods do have advantages in efficiency of storage. DPCM

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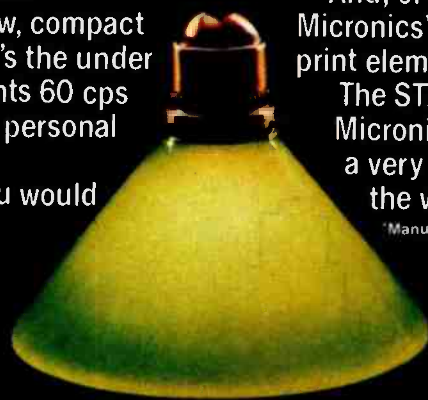

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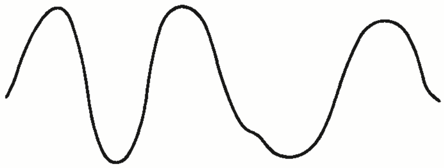

Figure 2a: *Analog speech waveform fed as input to the analog-to-digital converter.*

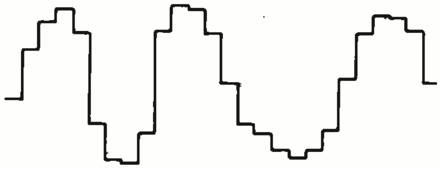

Figure 2b: *Speech waveform digitized by simple pulse-code modulation.*

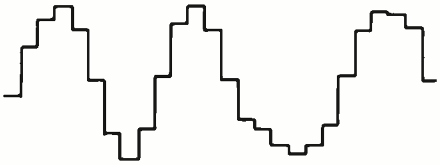

Figure 2c: *Speech waveform digitized by differential pulse-code modulation.*

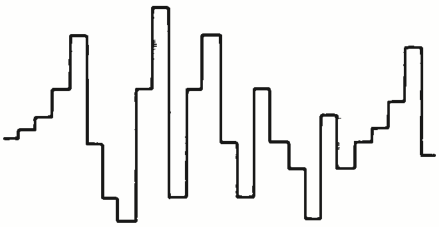

Figure 2d: *Speech waveform digitized by adaptive differential pulse-code modulation.*

is a variation of PCM that utilizes the fact that speech signals are not random but are closely related to sinusoidal functions. Thus, at each successive sample time the signal value is not random; rather, it is likely to be relatively close to its preceding value. DPCM, therefore, stores a value indicating the *change* from the last recorded sample rather than a value representing the sample itself.

The example in figure 2c shows the effect of DPCM encoding: a waveform stored and reproduced using only 7 bits (sign bit plus a 6-bit delta [change] value). Notice that the amount of space required to store the signal has been reduced by 12 percent, but no significant errors have been introduced. DPCM does suffer from the defect that the errors, the differences between the input and reproduced values, tend to become large when the signal is varying quickly and when the rate of signal change exceeds the rate that can be represented by the number of bits reserved for the delta value. (This condition is called *slope overloading*.)

ADPCM is a further development that cures this defect of DPCM. Optimized for speech storage, ADPCM offers better compliance with the input waveform and better intelligibility of the reproduced voice signal at lower data rates (see reference 3).

In ADPCM, each sample of the signal is encoded by a complex process that includes these steps: a PCM-value differential *dn* is calculated by subtracting the previous PCM-code value from the current value; the quantization value Δn (delta-n) is obtained by multiplying the previous quantization value times a coefficient times the absolute value of the previous PCM-code value; the PCM-value differential is then expressed in terms of the quantization value and is encoded in a small number of bits, sometimes as few as three.

As the rate of change in the signal increases, Δn grows to track the more rapid changes. As the rate of change becomes smaller, Δn becomes smaller and tracks only the subtle changes.

The comparison in table 2 shows large errors for ADPCM encoding, but this is not indicative of actual results achievable in a system set up specifically for ADPCM: typically the sampling rate is two to four times what PCM or DPCM encodings might use, but the storage required is still only 25 to 50 percent of that needed by PCM, with comparable sampling errors. One further problem: ADPCM is characterized by high-frequency error noise that must be filtered out to produce acceptable-quality speech reproduction.

Frequency-Domain Encoding

Frequency-based approaches seek to measure the frequencies present in a voice waveform and how they vary through time in distribution and in amplitude. Typically, if three or four dominant pitches are recorded, acceptable speech can be reproduced. The most popular of the frequency-based approaches is linear-predictive coding (LPC), which is used in the Texas Instruments Speak & Spell toy.

LPC is one of the most compact encodings; using LPC, only about 300 bytes are required to store one second of speech. However, in agreement with the second principle of speech storage mentioned above, the price in computational complexity for LPC is prohibitive in small-scale use. Converting a few seconds of PCM speech to LPC can take several minutes on a large computer, and converting LPC back to PCM is equally complex without the aid of a dedicated VLSI

(very-large-scale integrated) circuit. But recent information coming from semiconductor manufacturers indicates that custom LPC encoders may soon be available. These should revolutionize computer speech technology.

Rationale for Choice

Having ruled out LPC, during the development of Voice Lab I experimented with all three of the time-domain encodings I've mentioned. Finally, I settled on simple PCM because the analysis routines I planned to use require it. And because my primary use of Voice Lab was to be for speech analysis, I saw no point in using another encoding when the PCM encoding would have to be reconstructed before analysis could begin.

If you wish to use the Voice Lab units chiefly for speech synthesis, and storage is at a premium, I recommend using ADPCM encoding. (However, if you also want to do analysis, the routines for it must be modified.) Don't be discouraged from experimenting with other speech-encoding techniques. Only the digital-filtering and analysis units in Voice Lab assume that data in the speech buffer will be PCM-encoded. The speech-recording and speech-synthesis functions of Voice Lab will work well with any arbitrary encoding (including frequency-based approaches).

11	TWO	2000
2	TO	2000
3	TOO	2000
4	THREE	2300
5	FOUR	1500
6	FOR	1500
7	FIVE	1500
8	SIX	2800
9	SEVEN	2000

Table 3: *Partial vocabulary-directory listing produced by the Directory option. The current vocabulary is displayed in three columns: the left-hand column contains an index to the vocabulary word, the middle column contains the word, and the right-hand column displays the size in bytes of the encoded speech segment stored for that word.*

Voice Dictionary Unit

The Voice Dictionary (Voice_Dictionary) unit provides all speech-storage and speech-retrieval services. Voice Dictionary places speech bursts, read from the speech buffer, into a dictionary keyed with an arbitrary string. It can then retrieve that speech burst, inserting it back into the speech buffer, when presented with the appropriate string. The unit also provides some dictionary-maintenance services to remove unwanted words, examine the vocabulary, and erase the entire dictionary.

Although the dictionary is the bookkeeper of sound and text for Voice Lab, it doesn't have any knowledge of the encoding to the speech buffer. It just manages a warehouse of sounds on the disk. This vocabulary database is contained in a file called VOICE.DICT kept on a disk. The typical retrieval

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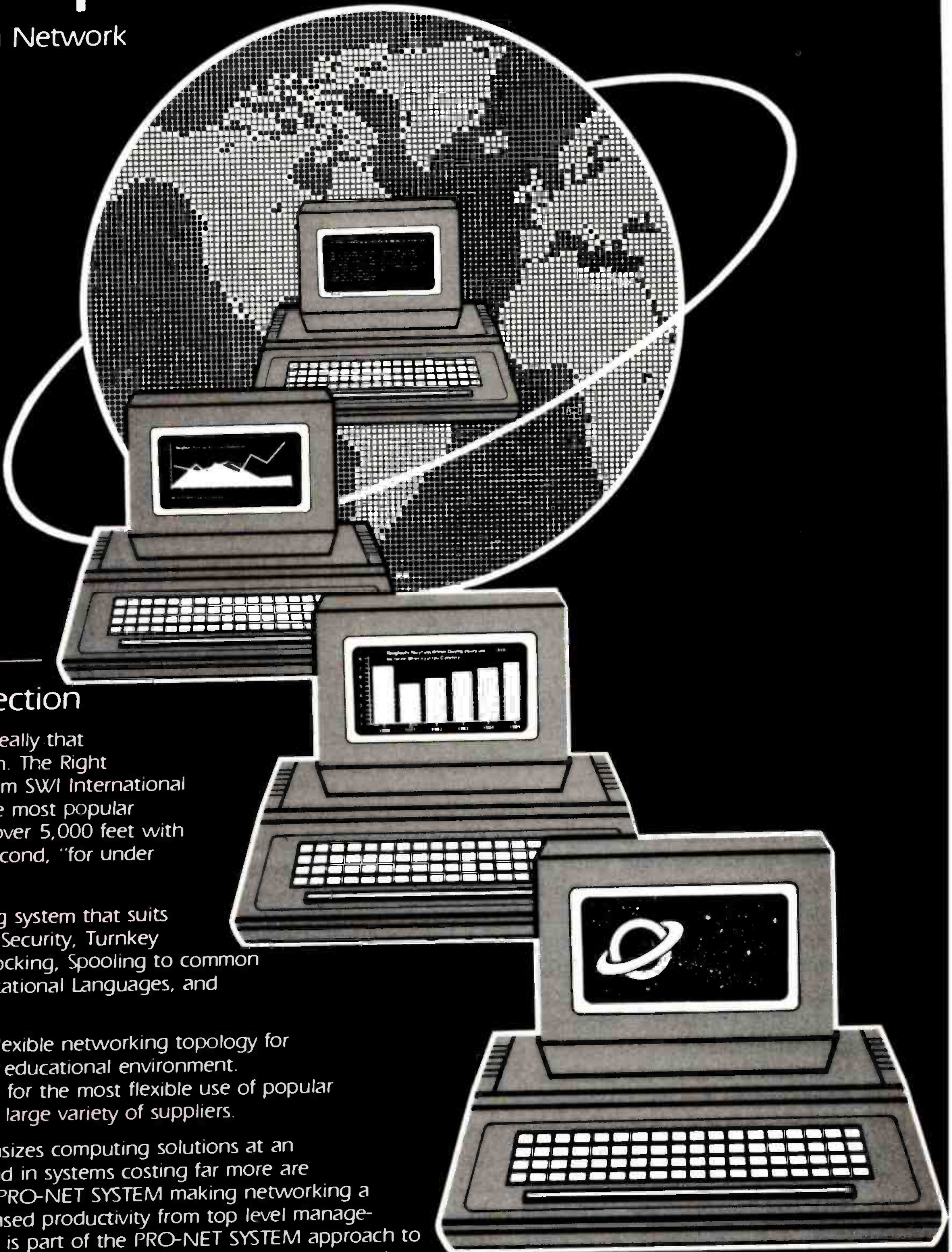

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four	M	down	than
for	N	equal	that
fore	O	=	times
5	oh	error	*
five	P	go	time
6	pea	greater	try
six	Q	>	this
7	queue	have	code
seven	R	hi	text
8	are	high	what
eight	hour	in	how
ate	our	is	
9	S	it	
nine	T	less	
0	tee	<	
zero	tea	minus	
A	U	–	
B	you	of	
be	ewe	off	
bee	V	on	
C	W	yes	
sea	X	no	
see	ex	know	
D			

Table 4: *Sample base vocabulary for use with Voice Lab.*

time for a given task is determined by the disk latency of your particular computer. On my system, which has reasonably quick 8-inch drives, I find the speech-retrieval time quite satisfactory. With Winchester-technology hard disks or semiconductor-memory disk emulators, response is nearly instantaneous.

As table 3 indicates, the dictionary is structured to handle homonyms: words that, while spelled differently and having different meanings, have the same sound when spoken. The words "two," "to," "too," and the numeral 2 are examples of a homonym set. Rather than repetitively storing speech samples for each of these in the database, the dictionary allows many words or strings of characters to cause the same digitized speech sample to be output.

The extent to which this technique can be used is not always obvious. Sometimes you can use near-homonyms, words that are not quite proper homonyms, with acceptable results, if you are willing to tolerate some mispronunciation. Examples of improper homonyms, which surprised me with their acceptability, are those in the group *R*, *are*, *our*, and *hour* and the pair *M* and *am*.

In my implementation of Voice Lab using PCM encoding, I find that a typical word requires between 1200 and 2500 bytes of storage. As such, a dictionary of minimum practical size (100 words) requires 350 blocks of disk storage in the p-System.

Voice Messages Unit

The Voice Messages (Voice_msg) unit is responsible for the conversion to speech of text represented by ASCII (American National Standard Code for Information Interchange) characters. This process is called text-to-speech synthesis.

There are two techniques commonly used in commercial equipment to synthesize speech from English text. In one approach, the sounds of each word that the computer can speak are recorded digitally and stored. When the computer reads the incoming ASCII character stream, it assembles the characters into whole words. It then looks up each word in the stored vocabulary list, and when it finds the word among those it "knows," it plays back the appropriate digital recording. The process is analogous to a person's learning to read by the "look-say" method (the learning method made famous by the "Sally, Dick, and Jane" reading primers of the early 1960s).

The second technique is called *phoneme synthesis*. In this approach, the ASCII character stream is analyzed and broken into groups of letters assumed to represent particular speech sounds within a word, the phonemes. Each phoneme is interpreted according to a set of rules and its corresponding sound is pronounced. Phoneme synthesis is similar to a person's learning to read by the phonics method.

Each approach has its advantages and disadvantages. The stored-list approach takes more space to store the speech information, and there will always be words that cannot be found, regardless of the dictionary size. In such cases, the word must be spelled out or skipped entirely. On the other hand, words that are found in the stored list will always be correctly pronounced and accented, whereas the phonetic approach always takes a stab at pronouncing words, but often pronounces them wrong (although this occurs less than 5 percent of the time for good translators).

For the sake of simplicity, I adopted the stored-list approach. While this technique limits the size of the computer's speaking vocabulary, Voice Lab compensates for this by allowing the vocabulary to be easily tailored to a specific application context. My experience with application programs led me to conclude that the

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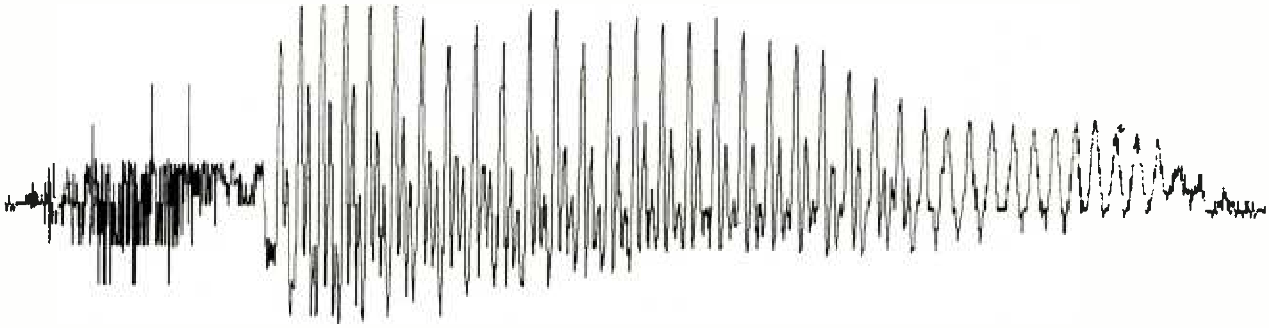

Figure 3a: *The waveform for my utterance of the word "two" with no filtration. Corresponding to a plot of the function V(t) over time, where V(t) is the voltage of the incoming analog audio signal, it graphically depicts the sound-pressure variation at the microphone, over a 400-ms (millisecond) period while the word "two" is being spoken. This graph was produced on an Epson MX-70 dot-matrix printer and then reduced to about one third its original size.*

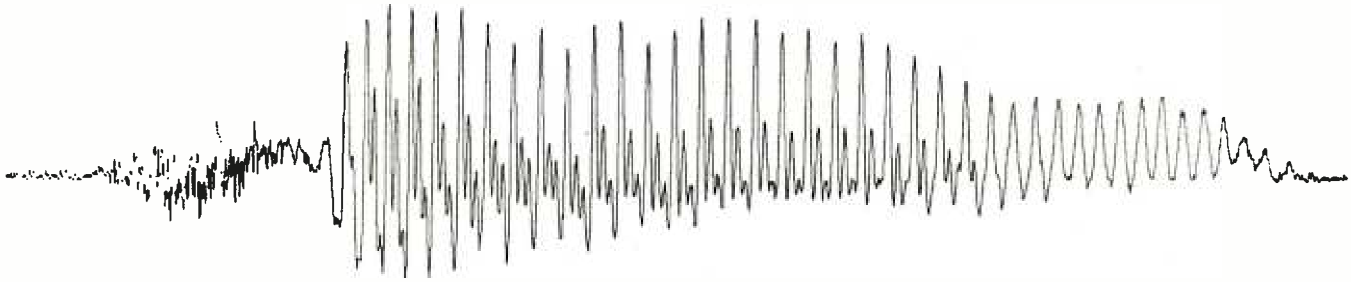

Figure 3b: *Utterance of the word "two" after the PCM samples have been processed by a low-pass digital filter.*

vocabulary for a given set of application programs is fixed and rarely exceeds a couple of hundred words.

The Voice Messages unit has two entry points. One is for speaking a single word, and the other is for picking words out of a character string and pronouncing them. In the event that the list does not contain the word, Voice Messages attempts to spell the word aloud to the listener.

In designing Voice Lab, I assumed that the basic word list would contain at least all the letters and digits. If you don't put at least these entries in, the Voice Messages unit will display on the computer's video screen the character code it cannot find an entry for, followed by a question mark. (This is normally a debugging feature.)

Punctuation marks and special characters are isolated and treated like any other character string. Thus, the occurrence of "+" in the input can evoke the utterance "plus" from the computer. Punctuation marks that are not found in the stored list are simply ignored, so that commas, semicolons, etc., do not clutter up the output. You can add entries of approximately 100 ms (milliseconds) of silence to the list for these symbols, thereby producing more lifelike spacing.

Table 4 contains the root vocabulary I have compiled over a period of time. When I begin to build a custom vocabulary for an application, I start with this basic list and add words and terms specific to my application.

Voice Display Unit

The Voice Display (Voice_dsp) unit contains an interactive utility routine that displays graphic information about the contents of the speech buffer. The information can be routed either to a printer or to the video display.

The program, as listed here, is configured to operate with an Epson MX-70 dot-matrix printer. Portions of the program that require modification to work with other popular graphics dot-matrix printers are commented on in the source code. Variations of the unit have worked with both the C. Itoh Electronics Prowriter and the Epson MX-80.

Three different plots are available: speech-waveform reconstruction, energy and zero-crossing counts, and spectral energy.

Figures 3, 4, and 5 are samples of the output produced by the printer. Each of the plots provides a different insight concerning the speech.

Figure 3a shows the waveform for my utterance of the word "two." This corresponds to plotting the function $V(t)$ over time, where $V(t)$ is the voltage of the incoming analog audio signal. It graphically depicts the sound-pressure variation at the microphone, over a 400-ms period, while the word "two" is being spoken.

Notice that the beginning of the plot is characterized by very rapid and jagged signal activity. This is typical of speech sounds called *fricatives*, which are unvoiced (or voiceless) sounds, akin to whispers. The only sound is

Text continued on page 202

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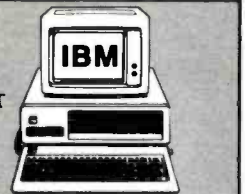

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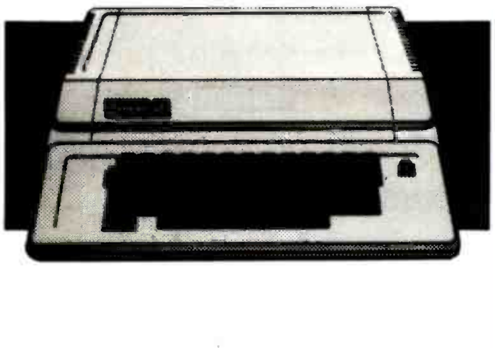

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Figure 4: *Raw zero-crossing plot (4a) and filtered zero-crossing plot (4b) for the spoken phrase "one, two, three."*

caused by air being expelled; the larynx or voice box is relaxed. These sounds do not have much power, and the waveform is of low amplitude. However, they do carry a lot of information about what is being said.

After the fricative "t," the waveform amplitude for "two" grows large. So large, in fact, that the top and bottom of the waveform are outside the range of my A/D converter, so that the top and bottom of the waves are cut off. This phenomenon is called clipping. Too much clipping badly distorts a speech signal, but a little clipping of large signals does not affect speech intelligibility too much. Signal plotting in Voice Lab can help you adjust the amplitude of your input signal so that it just barely clips; this is the optimal signal level. The center of the signal plot for "two" shows the start of the "oo" sound. Then the signal gradually decays as the exhalation of air ceases.

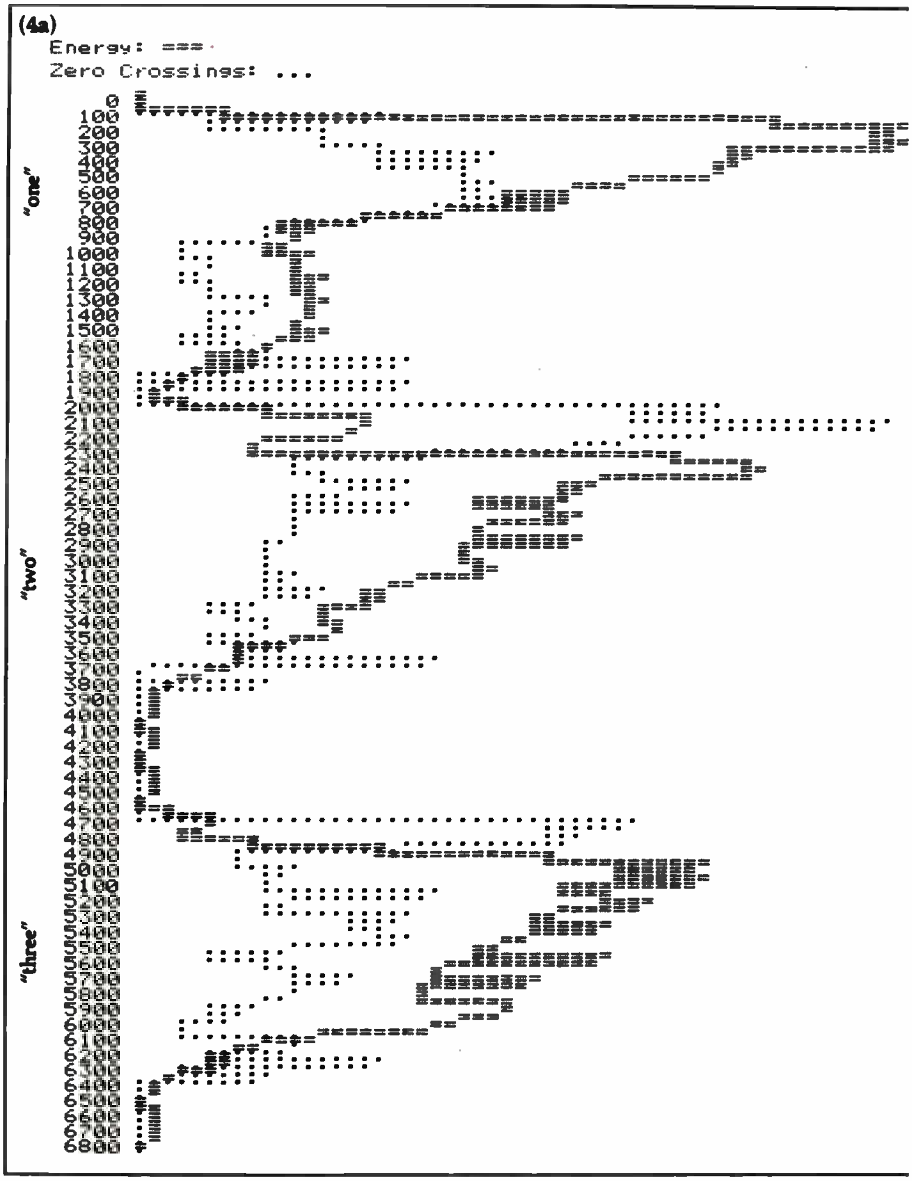
Not all the information in the waveform for a spoken word is useful for recognizing or classifying the word. Different utterances of the same word, even by the same individual, will have different duration, stress, and pitch. Furthermore, a waveform offers so much information that processing becomes computationally prohibitive. For that reason, two other feature-extraction plots are generated by Voice Lab. These have the potential of reducing the amount of information presented, while retaining the information allowing words to be distinguished.

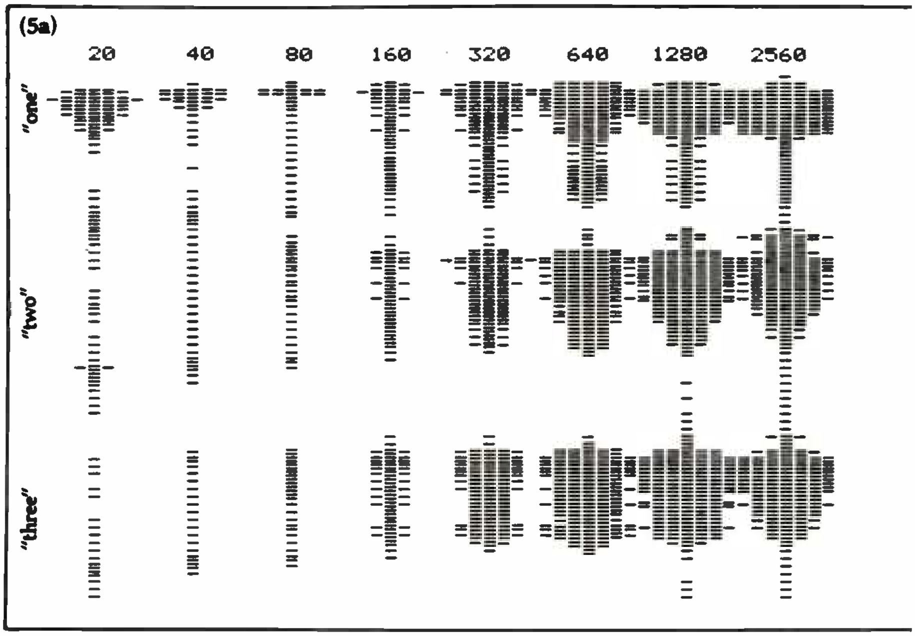
The first of these plots totals the speech energy and zero crossings on the same time axis. Figure 4 shows these for the utterance "one, two, three."

The energy plot $E(i)$ versus i is an approximation for the following computation:

$$E(i) = \frac{1}{100} \sum_{t=i\times 50}^{t=i\times 50+100} | V_t - 128 |$$

This function yields a result close to the instantaneous peak energy of





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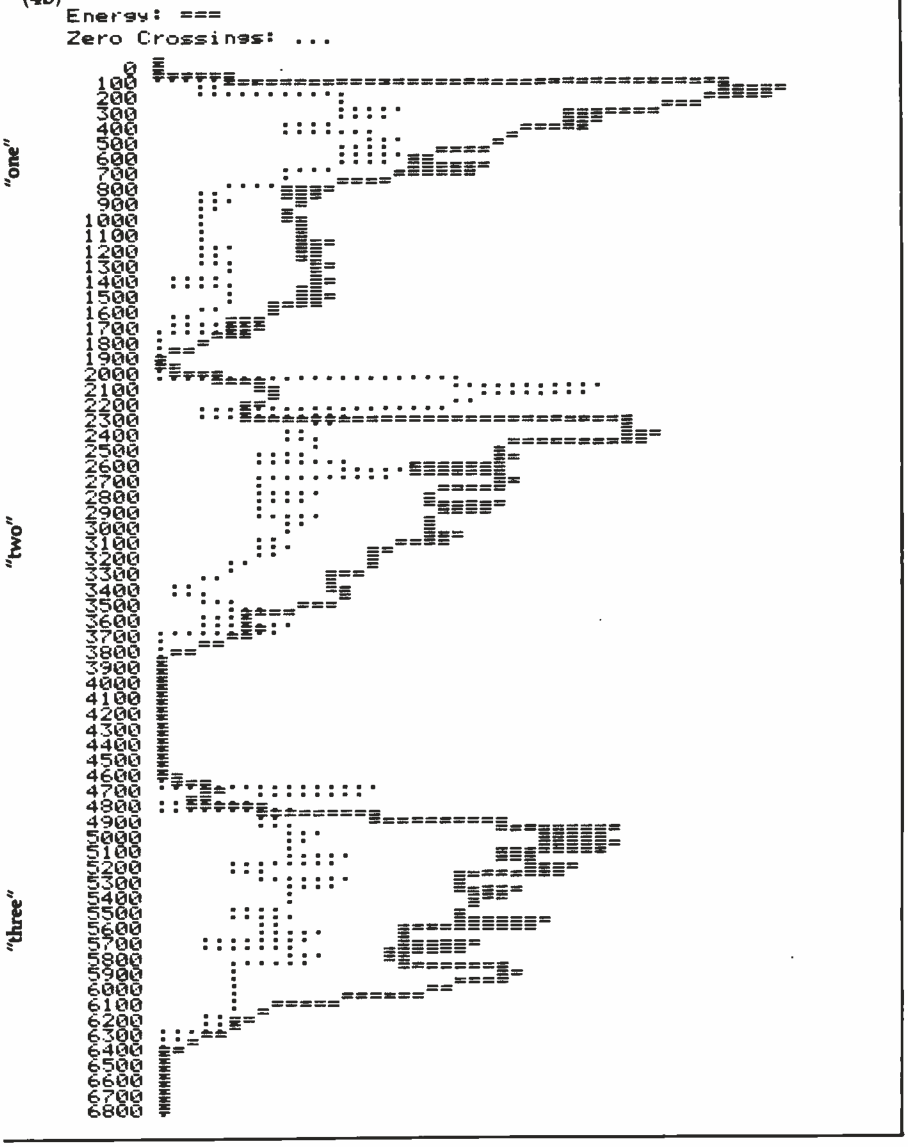

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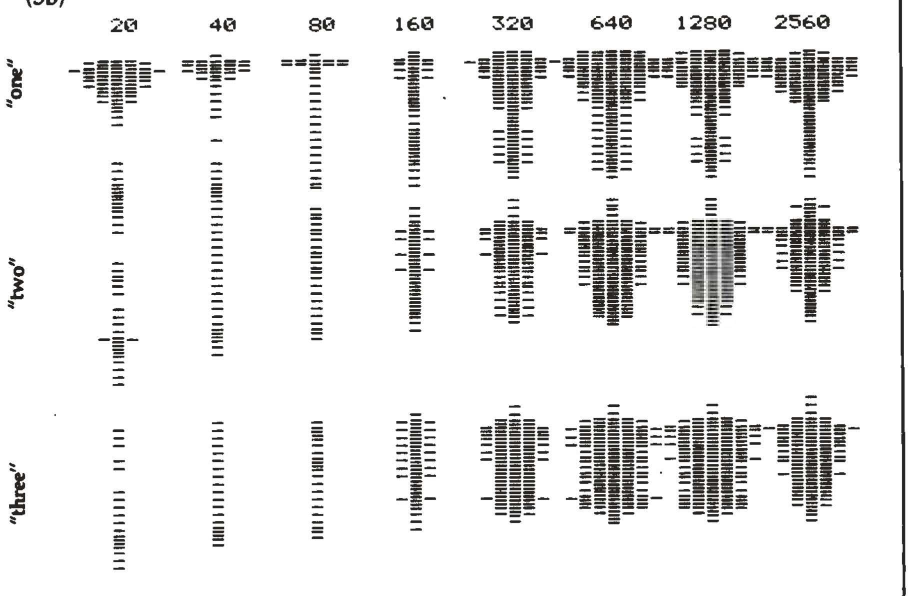

the waveform. As noted in the previous section, a high energy level is usually a sign of voiced speech.

The zero-crossing count is a good approximation of the average of the two dominant frequencies in a speech segment. These frequencies are called *formant* frequencies. The approximation is valid only during voiced speech. While fricatives are being sounded, the zero-crossing count becomes very high and represents another useful way to separate voiced speech from unvoiced speech.

The formula below shows how the zero-crossing count $ZC(i)$ is computed:

$$ZC(i) = \sum_{t=i\times 50}^{t=i\times 50+50} \text{if } V_{t-1}\times V_t < 0 \text{ then } 1 \text{ else } 0$$

Looking at the energy and zero-crossing counts for the word "two" in figure 4a, you can see how the word starts with the fricative sound "t," which is followed by a strong, voiced "oo." The "oo" linearly decays in amplitude as the pitch gradually grows lower.

The jump in zero crossings at the end of the waveform results from the noise caused by the cooling fan in my computer becoming the dominant sound as the speech dies away. A quieter computer would eliminate these zero-crossing jumps at the end of all the words. (I have verified this by tape-recording speech segments while the computer is off and playing them back into the machine.) The plotting algorithm compensates for this problem by squelching the zero-crossing display until a minimum of sound energy is present. If this were not done, the zero-crossing plot would vary randomly during periods of relative silence.

In addition to the waveform-function and zero-crossing plots, the spectral energy of the speech waveform

Figure 5: *Raw spectral-energy plot (5a) and filtered spectral-energy plot (5b) for "one, two, three." This kind of graph is similar in concept to a voiceprint but is obtained by a different method.*

can be plotted. This plot is the same as plotting E(i) where the incoming waveform has been filtered to accentuate the frequencies in a given octave. Rather than linearly plotting the amplitude in each octave, the program varies the thickness of the octave's time line. The darker the line, the more the frequencies in the octave are present. These plots are similar in meaning to voiceprints (see references 4 and 6), although they are computed using a different technique.

Voice Filtering Unit

The Voice Filtering unit (Voice_filter) is designed to allow you to selectively enhance or attenuate frequencies within the speech sample through digital filtration. It's something like a digitally implemented graphic equalizer that you can use to select specific frequencies to study. Furthermore, you can run the results of filtering through the filter again and again to get as sharp a cutoff as you like.

Digital filters can perform all the same functions that linear filters perform on analog signals. Furthermore, digital filters can do tricks that analog filters cannot (see references 7 and 11).

The Voice Filter unit allows you to construct a digital filter of up to five stages of the form:

$$X_t = k_0 \times V_{t-n0} + k_1 \times V_{t-n1} + k_2 \times V_{t-n2} + k_3 \times V_{t-n3} + k_4 \times V_{t-n4} + k_5 \times V_{t-n5}$$

Filtration is applied serially to the contents of the speech buffer from start to end. The best way to understand the effect of such a filtering operation is to set all the coefficients k_2 through k_5 to 0, and by taking the specific example below:

$$X_t = 0.5 \times v_t + 0.5 \times v_{t+1}$$

When this operation is performed on a speech segment where the signal is changing very slowly relative to the sampling rate (a low-frequency signal), then for most adjacent sample pairs $v_t = v_{t+1}$.

So taking the average of these signal samples does not change the waveform at all. For rapidly varying signals, this computation will tend to smooth out rapid changes by making them more gradual, thus filtering out high frequencies. Figures 3a, 4a, and 5a show the structure of the previously described examples prior to digital filtering. Figures 3b, 4b, and 5b show the effect of passing these examples through the above digital filter three times (the equivalent of a three-stage analog low-pass filter).

In figure 3, observe how the rapidly changing signals have been considerably smoothed by the filter, while the lower-pitched voiced portions of the waveform are relatively unchanged. Accordingly, figure 4b shows a lower zero-crossing total, because the higher-frequency components in the speech have been reduced.

The digital filter in Voice Lab is capable of functions considerably more complex than simple low-pass

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filtering, but we don't have room here to consider them all.

To Be Continued

Indeed, there is no more room in this month's BYTE for me to continue at all. But next month, in part 2, I'll describe how the system actually operates. ■

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About the Author

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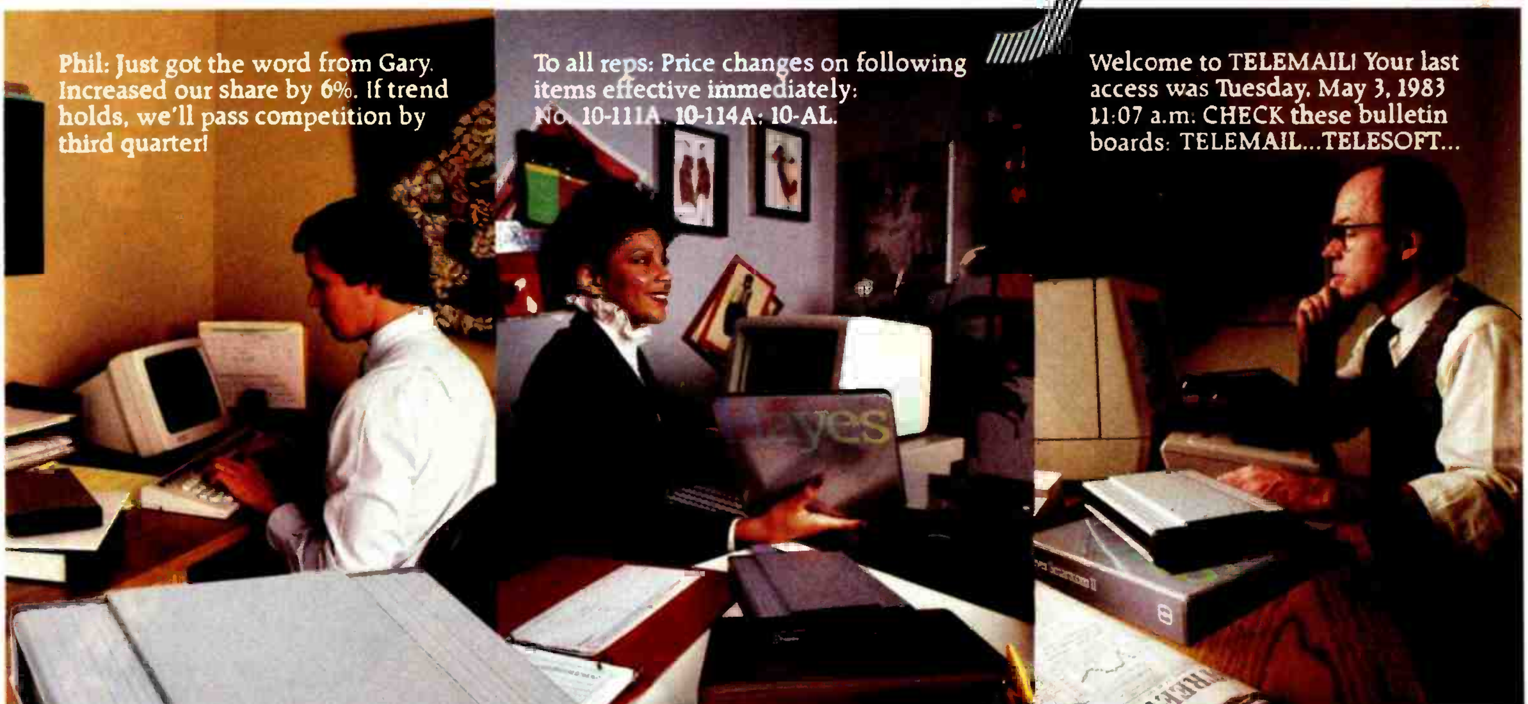

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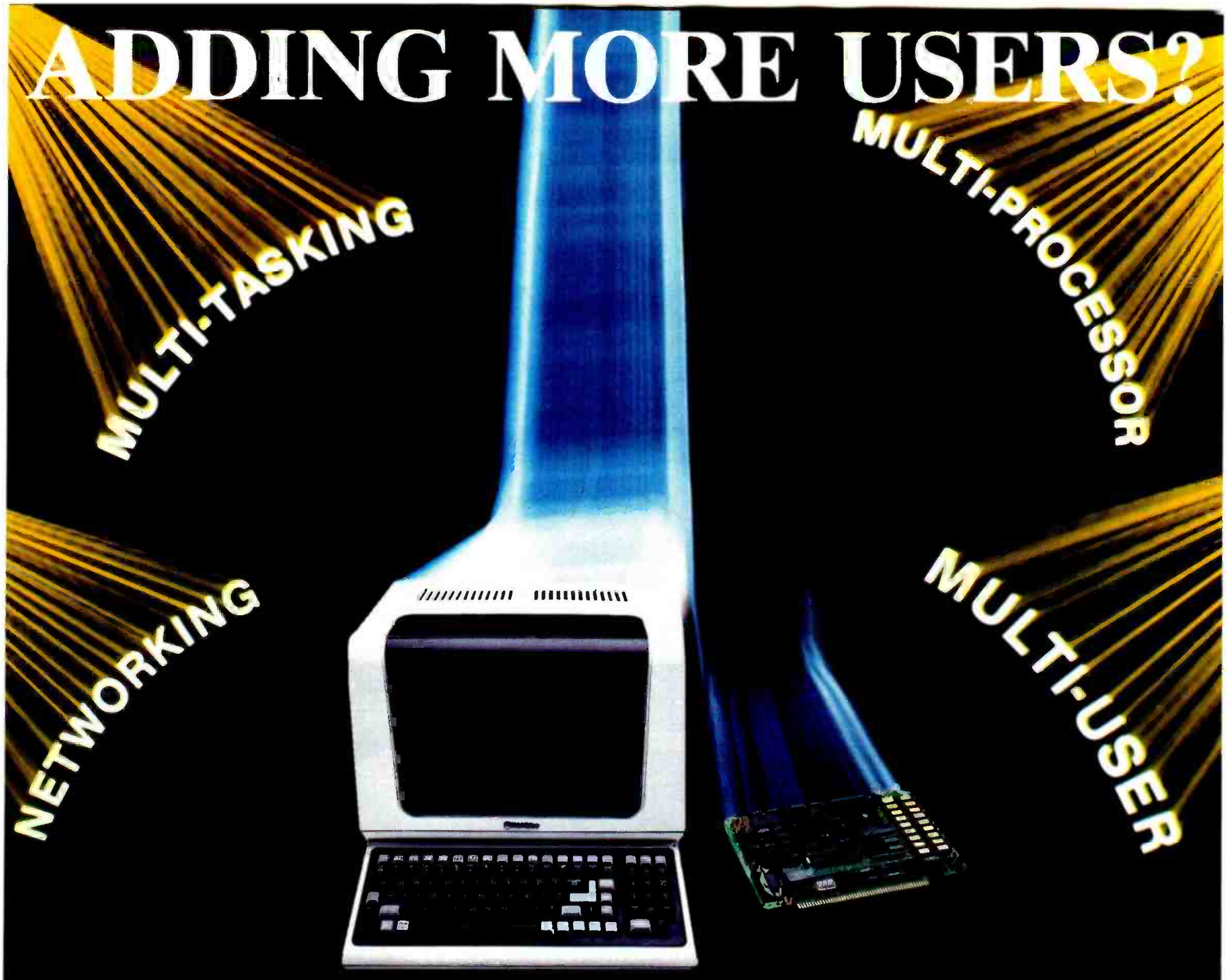

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Parallel I/O Ports for H-89 Computers

You can add 64 input/output ports plus a Centronics-type printer interface to your Heath-/Zenith-89 computer.

by Ronald La Claustra

About the only major failing of the Heath-/Zenith-89 computer is the unavailability of parallel input/output ports. This article describes a method of bringing the required data, address, and control lines out of the H-89 so you can add 64 I/O ports and an additional dedicated port for a Centronics-type printer.

Moreover, this example should serve as inspiration to other users of nonmainframe computers to work out similar circuits, perhaps ultimately yielding a new I/O port standard bus that would simplify design of accessory boards.

Photo 1: *The installed interface showing cable placement. Note that the cable connectors of P1 and P2 do not connect to all the pins on the interface board because they were wired for an earlier version. Yours should fit in exact correspondence.*

The interface circuit board plugs into one of the bus connectors on the left side of the processor board (see photo 1). The only alteration to this circuit board is the addition of a single wire lead. The needed control lines are taken from a Heath accessory board, which plugs into the right side of the processor board. The interface outputs are brought to the rear panel of the computer where they end in two D-type connectors. From one connector a cable leads to a new motherboard for the added ports. The printer cable attaches to the other connector. The entire project should cost less than $80.

The printer output must be controlled by a device-driver program that runs as part of the operating system (HDOS or CP/M). You can write your own driver or buy one.

Circuit Description

In the interface circuit diagramed in figure 1, data and address lines are buffered to prevent problems with the processor. The data lines are handled by a three-state bus transceiver, which buffers and controls the data switching (read in, write out). The control lines are buffered and inverted for further processing by the logic circuits. (Note: control-line names are capitalized, and an "L" at the end of the name means the line is true on a low pulse. Thus, BRDL means buffered read asserted low. Refer to Heath schematics.) Two input NAND gates derive new signals that control data direction and printer strobing. The clock pulses are inverted twice to return them to the correct phase.

The two separate bidirectional data buses must connect in an orderly fashion. Thus, the following method of controlling the external bus must be used. It's based on the particulars

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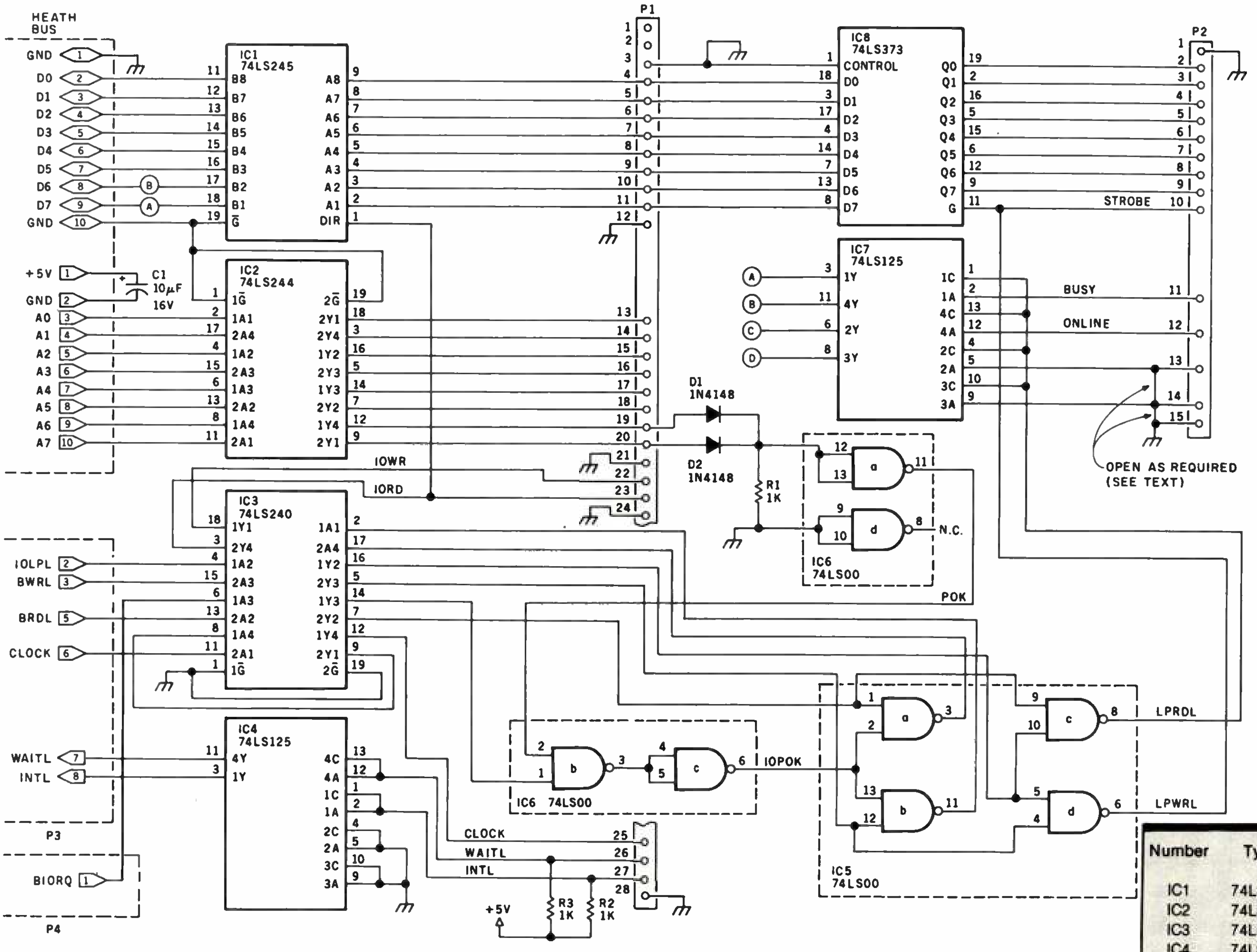

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Figure 1: *The schematic diagram for the H-89 parallel I/O port bus and printer interface.*

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Some simple circuitry handles this problem. R1 and the two diodes connected to address lines D6 and D7 form an OR gate. If the port address appearing on the bus contains either of these bits, the logic cuts off the control pulses (IOREAD, IOWRITE) going to the external bus and transceiver direction control pin, thus preventing the transceiver from switching direction at the wrong time.

If the processor wants data, say, from the disk-drive port, and the transceiver switches to allow a read of the external bus at the same time, two conflicting data words appear, causing the computer to crash or prevent it from bootstrap loading. This condition would happen if the same read control signals employed on the processor board were used to directly control the transceiver. Limiting the response of the interface only to those port addresses reserved by Heath for the user (0 to 63 decimal, 0 to 77 octal) eliminates this problem by preventing the normal reading of internal I/O ports from crashing the machine. Thus, the OR gate detects the illegal addresses and enables only those ports that can be used safely.

There are two input lines from the external bus—WAITL and INTERRUPTL (or INTL). A pulse on the INTL line causes the processor to jump to a specified address in memory where you have put a machine-language routine, which is then executed. Several interrupt priority levels are present in the H-89 hardware. Those available are levels 3, 4 and 5. However, they are not reserved by Heath and may be taken up by other accessories, so check your manuals before using them.

A pulse on the WAITL line keeps the clock pulses from running the Z80 microprocessor, thus freezing its current state to allow the Z80 to be used with slow I/O circuits such as certain memory ICs (integrated circuits). The I/O circuit would activate the WAITL line and hold it until it had finished accepting the data word. This wait state is no problem when static memory is used but could be catastrophic with the H-89's dynamic memory, which needs to be refreshed periodically to prevent loss of stored data. This refreshing is done by addressing each memory location at least once every 2 milliseconds (ms). The Z80 is responsible for refresh addressing, and if the WAITL line is activated, the Z80 stops dead. Therefore, the WAITL line can't be used with mechanical devices like printers. Use it only with circuits having write acceptance times much shorter than 2 ms.

Both WAITL and INTL are sent through three-state buffers whose outputs connect to the processor only when their inputs are asserted.

The Printer Circuit

The printer output consists of an 8-bit data latch controlled by a negative pulse, which is also the strobe line for the printer. We use the same port address that Heath hardware has decoded as IOLPL, permitting access to the printer through the operating system in the usual way. (You can also use the other serial port addresses.)

The following description is based on a Centronics-type printer but applies to most other parallel types. The data going to the printer can arrive much faster than the printer can handle it; therefore, we need a way to tell the computer (through the device driver) to stop sending data while the printer is printing.

To send this message, the printer's BUSY signal line goes high while the printer is accepting and processing data. The BUSY line and up to three other inputs are brought into the H-89 along the printer cable and are then sent to three-state buffers. The outputs of these buffers are controlled by the LPRDL line, which is activated when the processor wants to read the printer status port. The outputs are


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Photo 2: *A close-up of the circuit board showing parts and jumper placement. Red dots show pin 1 on each IC.*

sent directly to the processor bus, bypassing the transceiver because the printer address is not a legal address and thus the transceiver is not switched in the correct direction for a read. What those other three input lines contain depends on the requirements of your device-driver program.

The Device Driver

A device driver program is used by your operating system to communicate with a peripheral device. The program is tailored to the requirements of that device. If you need to use the device the operating system calls the driver and passes all data to it, leaving the control particulars to the driver.

A basic driver program may correctly send data to, and control, the printer but may not be able to access all of the printer's functions. I wanted easy access to all the modes of the Centronics 737 and so had to come up with a 737 driver. Not being a whiz at assembly language, I decided to use one offered by FBE Research (POB 68234, Seattle, WA 98168). It is written for HDOS (Heath disk operating system) and the H-89 printer adapter but can be used as is with the one presented here.

Along with the BUSY line on bit 7, the FBE driver needs the printer ONLINE signal on bit 6. All you need do then is send this signal through a three-state buffer and on to the processor bus just as with the BUSY line. The driver program checks the status of these bits and controls data transmission accordingly. If the driver you use needs any of the other printer status lines, handle them in the same way unless the driver uses interrupts, in which case you would connect the BUSY printer line to the appropriate interrupt line. CP/M users may have to modify the BIOS (basic input/output system).

Construction

Heath sells a wire-wrapping board (H-88-10) that can be used to build this circuit, but I chose to make an etched circuit board (see photo 2). If you want to make one, use the positive pattern shown in figure 2. Kits are available that let you chemically lift the pattern off the magazine page for use in exposing a photosensitized copper-clad board. Photo 2 serves as the parts mounting diagram. Red dots signify the location of pin number 1 on the ICs.

Because the board is one-sided, it requires several jumpers: 18 on top and up to 4 on the rear. The rear jumpers are used in the printer input circuit (output of buffer to Heath bus) with wires going between the lettered points in photo 2. One end of each wire goes into a pad near IC7. The end that connects to the data bus is soldered to the same pad as the processor connector (see photo 3). Figure 1 shows the correct connections to use with the FBE program.

I could not find a source for the required processor bus connectors (right-angle female with 0.1-inch spacing) so I ordered both lengths, 10 and 25 pins, from Heath (part numbers 432-1074 and 432-1076). It is through these that the interface gets the data, address, ground, and +5-volt (V) supply lines. The rest of the connectors on the project board also have 0.1-inch spacing but are male. The data, address, IOWRITE, IOREAD, 2.048-MHz CLOCK, WAITL, INTL, several ground, and unassigned lines form the new bus cable, which leaves the board through the large 28-pin connector, P1. Data, LPWRL (strobe), four input lines, and grounds leave through a right-angle connector (P2). Entering the board are IOLPL, BWRL, BRDL, 2.048-MHz CLOCK, WAITL, and INTL through the last cable assembly (P3). There are no connections to pins 1, 4, and 9. BIORQL comes in on a single pin (connector P4).

BIORQL is the line that must be directly tapped from the processor board. Remove the processor and, using a 9-inch piece of thin shielded cable, connect the inner lead to IC U509 pin 9 and the shield to pin 10. On the other end, cut back the outer insulation and shield, leaving out about 1 inch of the insulated center conductor. Strip ½ inch of this and solder it to a single female 0.1-inch connector and cover the connection with tape or heat-shrink tubing. Replace the processor after running the cable underneath it.

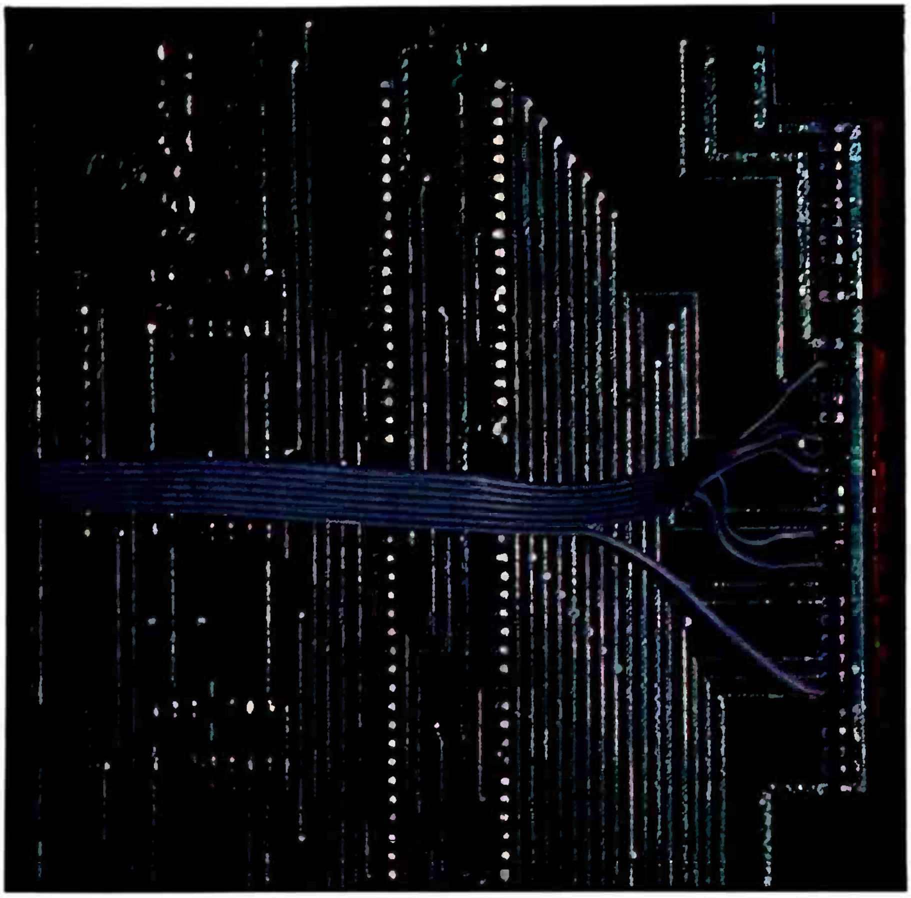

Photo 3: *How wires are to be connected when they go to the same pads as the bus connectors. Shown are the control signals being tapped off the serial interface board.*

To get the bus and printer lines out of the cabinet, use 23-inch ribbon cables with female 0.1-inch connectors on one end and female D connectors on the other. For the bus use a 25-pin D connector and for the printer, a 15-pin one. The pins on the interface board are numbered from the top down; follow this numbering

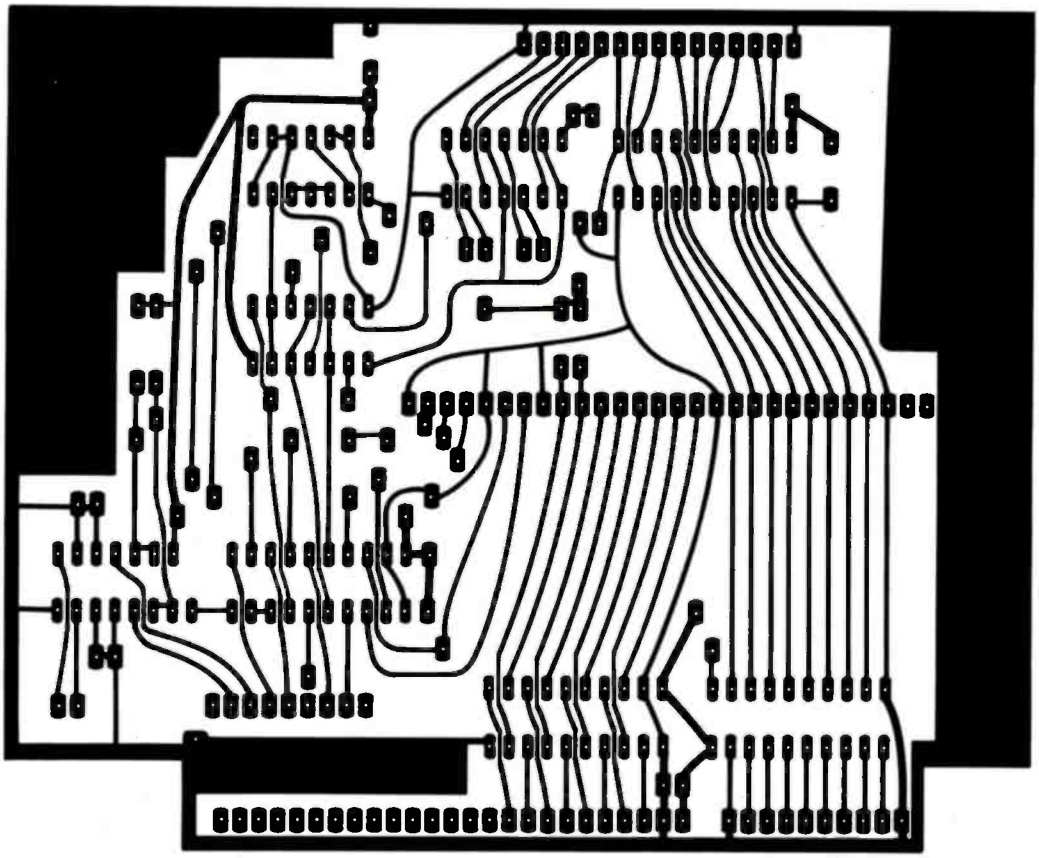

Figure 2: *Layout of etched circuit board. When exposing the board, place this artwork face up on the copper-clad side.*

when wiring the bus D connector. In order to get the 28-pin bus out through a 25-pin D connector, do not connect ground wires 21, 24, or 28 to the D connector. Leave each loose and go to the next wire. When done take wire 21 and attach it to pin 3 along with wire 3. Twist wires 24 and 28 together and connect the result to pin 12, thus adding them to wire 12 and increasing the capacity of ground lines 3 and 12. When you wire the new bus board, leave a bus conductor free for each of these ground lines (that is, leave a space for them when you get to their number). The etched board has these conductors already grounded. You should end up with the lines in the order specified for P1 (see table 1). For the printer, wire the D connector as listed in table 2.

The 20-inch P3 cable has at one end a 9-pin female 0.1-inch connector, while the other ends are soldered to the same pads as the bus connectors on an accessory board (photo 3). This board can be either the cassette, serial, or other interface; it occupies one of the two innermost connectors on the right side of the processor board. The far right connector is reserved for the 5-inch disk controller and lacks the IOLPL signal. If you don't have a suitable board or run into trouble, you can solder the leads of the cable directly to an extra 25-pin Heath bus connector.

The signals to be tapped off the 25-pin bus are, counting from the top pin, as follows: BRDL pin 6, BWRL 7, WAITL 8, IOLPL 11, 2.048-MHz clock 13, and (choose one or none) the interrupts: INT 3 pin 18, INT 4 pin 19, and INT 5 pin 20. Wire the cable to these points in the order specified for P3. At the 0.1-inch connector end, pins 1 and 9 are not used at this time, so you can leave them unwired. Also, skip pin 4.

Construction Tips

When mounting devices on the board, use sockets for the ICs. The capacitors serve to bypass the power lines. If you're not using the etched board, put the Tantalum capacitor as close as possible to the 5-V input pin of the processor bus connector. (Depending on space, you may have to connect this capacitor to the rear of the board.) The 0.1-microfarad capacitors go near the individual IC pins.

When you connect the board, route the bus and printer cables over the processor and terminal panels to the rear (photo 1). Keep the jumper cable (P3) away from the horizontal output transformer to help prevent noise pickup from the transformer.

The unconnected pins may be used to carry other signals you may use in the future. You can also work with two unused buffers on IC3. The diodes must be fast switching types.

Exposure of GC brand presensitized boards is about seven minutes in direct sunlight through the single sheet of glass holding the positive art to the board. Keep the light perpendicular to the board's surface. Use boards made of epoxy glass. Wash assembled boards with flux remover.

The printer cable should be the round shielded type to reduce radio-frequency interference. You may have trouble, however, finding a printer-end connector that accepts this type of cable. I had to splice on a short piece of ribbon cable. Keep the length around 6 feet.

Suggestions

Early-production H-89s (without the external brightness control) have space on the rear panel for two D connectors in which you can mount the bus and printer connectors. However, if the connectors are occupied, I recommend you get the junction-box adapter from Heath. Heath's H-88-6 backplate modification kit gives you enough room to route your cables and mount the connectors (photo 4). The 25-pin D bus connector can go into one of the three serial I/O holes, and the printer connector can go out the hole marked "488" (use a metal strip to make up the space), or you can cut new holes. The kit also has a cable that brings out the floppy-disk bus and lets you add brightness control.

Because the processor board must be removed for installation of the P4 cable, you should also consider putting in the new ROM kit if yours is an older H-89. The H-88-7 replacement ROM kit enables you to use the H-47, add the last 16K bytes of memory for a maximum of 64K bytes, and use standard origin CP/M. The only problem is that you can't use the cassette interface board anymore; you must remove it to allow the H-89 to boot up. Use the alternatives stated above if you run into this problem. If you add the last 16K-byte expansion, leave an empty connector between it and the port interface board; otherwise, you may get interference on the video screen.

If you have the serial I/O board installed and you'll be using the parallel printer port, you must remove the serial ICs from the printer port address. On the two-port serial board, just move the chips down to the empty sockets on the board and use them at that port.

Pin	Function
1	unassigned from interface
2	reserved for board reset
3	main ground, interface return #1
4-11	data 0 to data 7
12	main ground, interface return #2
13-20	address 0 to address 7
21	bus ground
22	IOWR
23	IORD
24	bus ground
25	system clock, 2.048 MHz
26	WAIT L
27	INT L
28	bus ground
29	+5-V supply
30	+12-V supply
31	−12-V supply
32-35	unassigned bus lines
36	reserved for 1.843-MHz clock

Table 1: *Pin assignments for the H-/Z-89 parallel I/O system.*

0.1-Inch Female Pin	Signal Carried	15-Pin D Female Connector Pin
1	ground	11
2	D0	2
3	D1	3
4	D2	4
5	D3	5
6	D4	6
7	D5	7
8	D6	8
9	D7	15
10	STROBE L	1
11	BUSY IN	13
12	ONLINE IN	12
13	SPARE IN	10*
14	SPARE IN	14*
15	ground	11

Table 2: *Wiring of connectors for the printer cable from the interface board to the rear panel of the H-89. (The output D connector arrangement corresponds to that of the Atari 850 parallel printer port except for those marked *, which are unused on the Atari.)*

Tryout

With everything connected, remove the CRT socket (to keep from burning out the video display if you have to switch the power repeatedly) and turn on the H-89. If you hear two beeps you're OK and can reconnect the video display. If not, you have a problem. Check for shorted connections in the cables as well as the circuit board. Also check the transceiver direction pin (pin 1) with an oscilloscope. There should be no activity on it unless you are reading a legal port.

Once you get the two beeps, boot up with a scratch copy BASIC disk. You can check operation of the new bus in BASIC programs with the INP and OUT port commands in FOR . . . NEXT loops. Count through all the port addresses, 0 through 255, and read them with the INP(X) statement. If you get through without crashing the computer, you're in business. To send a data byte to the new bus, use the OUT command, specifying which port is to receive it.

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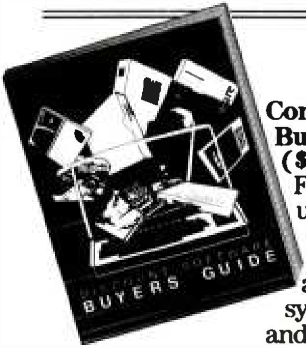

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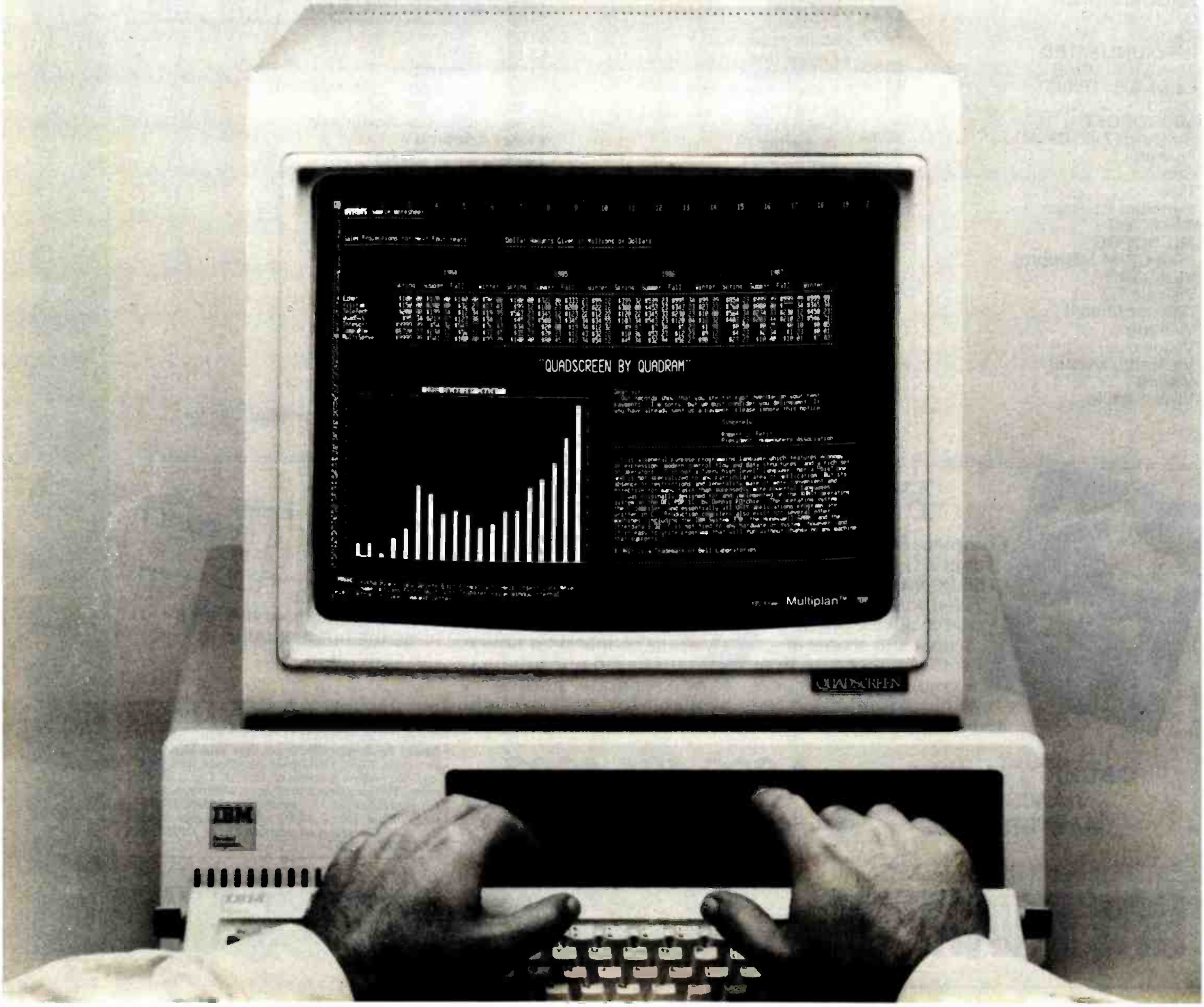

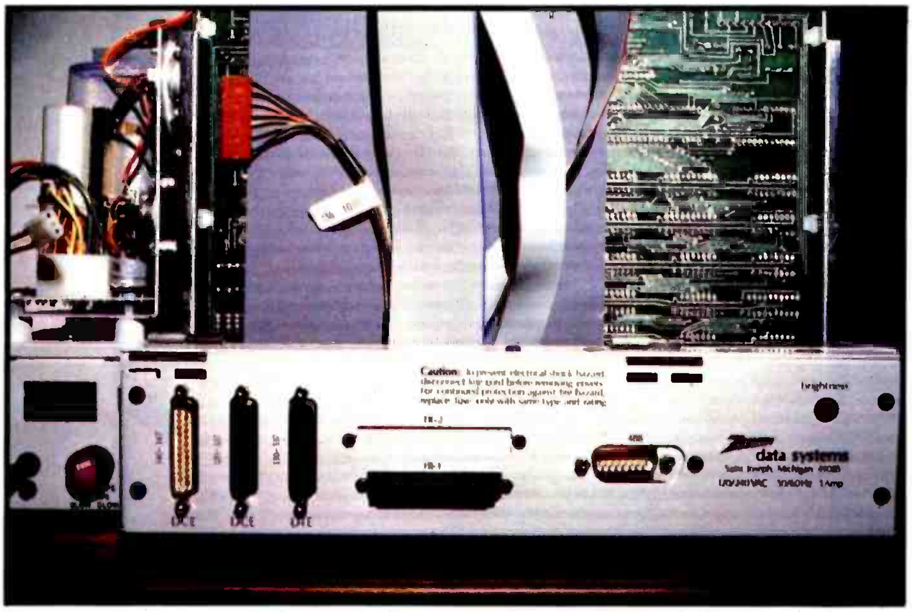

Photo 4: *The rear panel of an updated H-89, as fitted with parallel port bus connector (leftmost) and parallel printer output (small rightmost). Male D connectors have been used here but female ones would be better protected from accidental shorts.*

Photo 5: *The new port-bus assembly, fitted with female 0.1-inch bus connectors and 10-kilohm termination resistors. Insert circuit boards beginning with the connector farthest from the cable end. The separate power supply is not shown.*

in a similar way by sending ASCII (American National Standard Code for Information Interchange) characters out to Heath port 224 (decimal) with the statement OUT 224,13. (The 13 is the decimal equivalent of a line feed.) Then set up a FOR . . . NEXT loop that steps through the numbers between 32 and 126 (inclusive) to print the ASCII character set. For the H-89 don't use the OUT statement to a port address greater than 63 decimal unless you know what's out there—you could crash the machine.

If you have the device-driver program, you can call the line printer from your operating system. See your manual for the correct commands. Configure the FBE driver for port 340 octal.

The New I/O Bus

The new external bus leads to a motherboard with 36 parallel conductors and female 0.1-inch connectors mounted an inch apart (see photo 5 and figure 3). The ribbon cable attaches to pads at the left end, and supply power enters via the binding posts at the right end. Line 1 is at the top.

The ribbon cable connecting the computer to the motherboard should be a 3-foot-long 27-conductor one. Three feet is long enough to be convenient, while not so long that it causes electrical problems. Why 27 conductors for a 25-line feed? Because we need to double up the ground lines to keep the signal return a low-impedance path. Before you start wiring, prepare the ribbon cable as follows: separate the conductors at both ends of the cable for about 2 inches and then strip off ¼ inch of the insulation. Then from one edge count in two conductors. The next two con-

This interface will allow you to use your H-89 to experiment with talking computers, music synthesis, remote control, and more.

ductors (3 and 4) should be twisted together and soldered, thus making one double conductor. Proceed from the next conductor (5) to the 13th and 14th. Twist and solder these two in the same way. Do the same at the other end of the cable (being sure to count from the same reference edge), and your 27 conductor cable has been reduced to 25. You can now wire the D-25 connector and motherboard with the cable using the reference edge as line number 1, counting the paired conductors as a single line (remember to skip the "missing" motherboard ground lines).

If you don't plan to use the wait or interrupt functions (the usual case) you may want to leave these lines unconnected for safety—an erroneous pulse on either one could crash the machine. When you reach their pads on the motherboard, tape them back to the cable. This way they remain accessible for when you need them.

Power for the accessories to be plugged into the bus must come from a separate supply circuit. Don't try bringing power lines out of the H-89. The common grounds, however, must be connected together. If you make the etched board, power connections from the center are ground, +5 V, +12 V, −12 V. Twenty-eight 10-kilohm resistors serve to terminate the bus lines, reducing crosstalk between conductors and cleaning up the waveforms of the pulses. The yellow item under the ribbon cable is a 1-microfarad Mylar capacitor that serves to filter the +5-V line.

To use the new ports you just need circuitry to isolate the port address; then combine it and the IOREAD or IOWRITE signals to control data latching. For more detailed instruction in this technique see Steve Ciarcia's article "I/O Expansion for the Radio Shack TRS-80, Part 1: Principles of Parallel Ports" (May 1980,

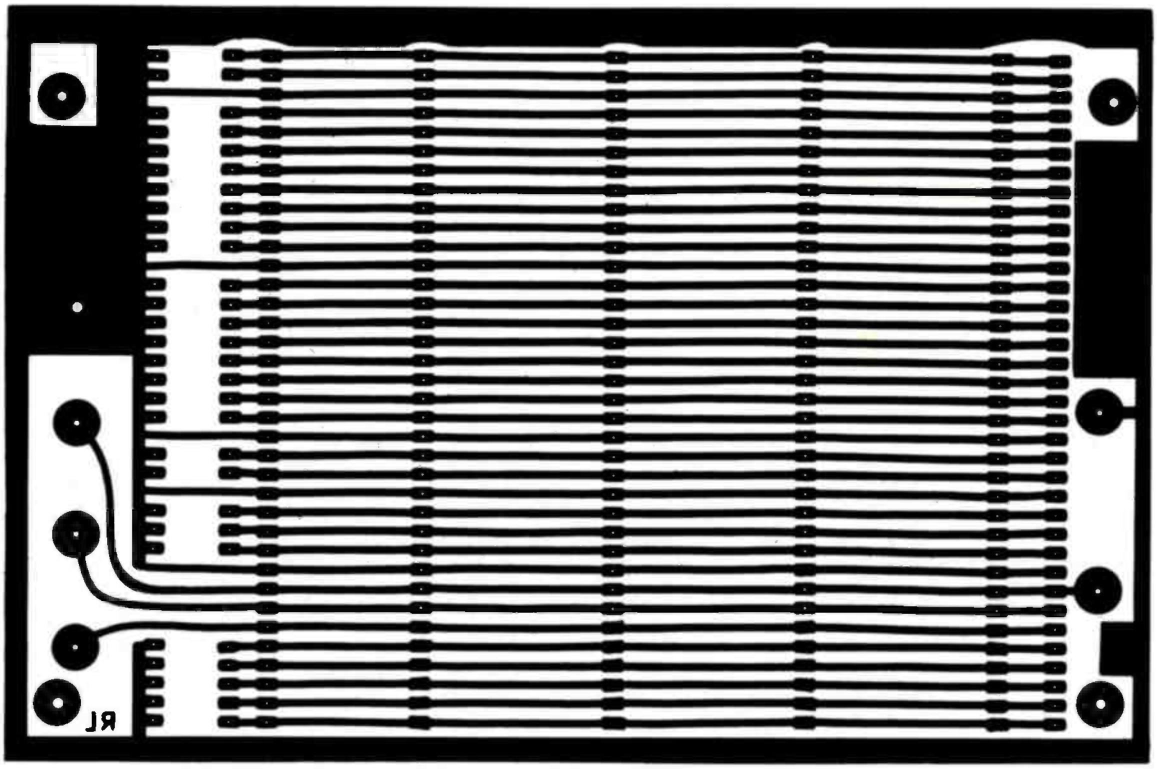

Figure 3: *Layout of the bus board. When exposing, the "scoops" in the ground perimeter are at the top, and the power supply pads are on the left. Large pads in the corners are for mounting-screw holes. The lead holes in some lower pads have been blocked out; open these with a pin on transparency before exposing.*

page 22). This circuitry plugs into the motherboard. The data lines can then be led off by cable or can stay on the board and go to other circuitry (digital-to-analog converters, etc.). Keep in mind the fanout limits of the interface buffers when you connect circuitry to the new bus.

Conclusion

In short, this interface can save you money in dispensing with serial conversion when adding a printer, give you a wider choice in printers, and let you experiment with talking computers, music synthesis, analog-to-digital and digital-to-analog converters, remote control, and all the other functions you thought you couldn't do with your all-in-one H-89. ■

About the Author

Ronald La Claustra (882 57th St., Brooklyn, NY 11220) is an electronics technician currently working with microcomputers.

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Bubble Memory for the Apple II

BUBDISK

by Peter Callamaras

Memory is a very important part of a computer. After the price, the question most people ask when they shop for a computer is how much memory the system has. For most small-business systems, and for the higher-priced personal computer systems available today, the starting size of the computer's main memory is usually 64K bytes, which is the limit for most 8-bit processors. Many of the newer systems can also be expanded up to 256K or 512K bytes of internal memory. Basically, the more RAM (random-access read/write memory), the better.

Many early Apple II owners can remember when the "standard" Apple came with a whopping 16K bytes of RAM, and the main storage system for programs and data was the cassette. Now, thanks to bank-switching techniques (which switch banks of memory into and out of the 64K-byte address space) and memory-management systems, the old 64K-byte limit has been effectively eliminated. Today, many hardware memory-expansion modules are available for the Apple, and they usually come in packages of 128K bytes or multiples thereof.

Coincidentally, the amount of data that can be stored on a single Apple II floppy disk with the DOS (disk operating sytem) is just under 128K bytes. Looking at the size of memory available now and the amount of data on a disk, it seems obvious that if you have a 128K-byte memory card that stores information as a disk would, you can now work at RAM speeds on disk-based data. Because it can take several seconds to access a disk drive and then read or write data to or from the disk, the potential for reduced processing time is excellent. An expanded memory means you can do a lot more in less time.

Once the processing is finished, however, you have to write the final information to a disk if you wish to save it. If you lose power in the middle of a session, you also stand to lose all the data on the memory card because of the volatile nature of standard memory chips.

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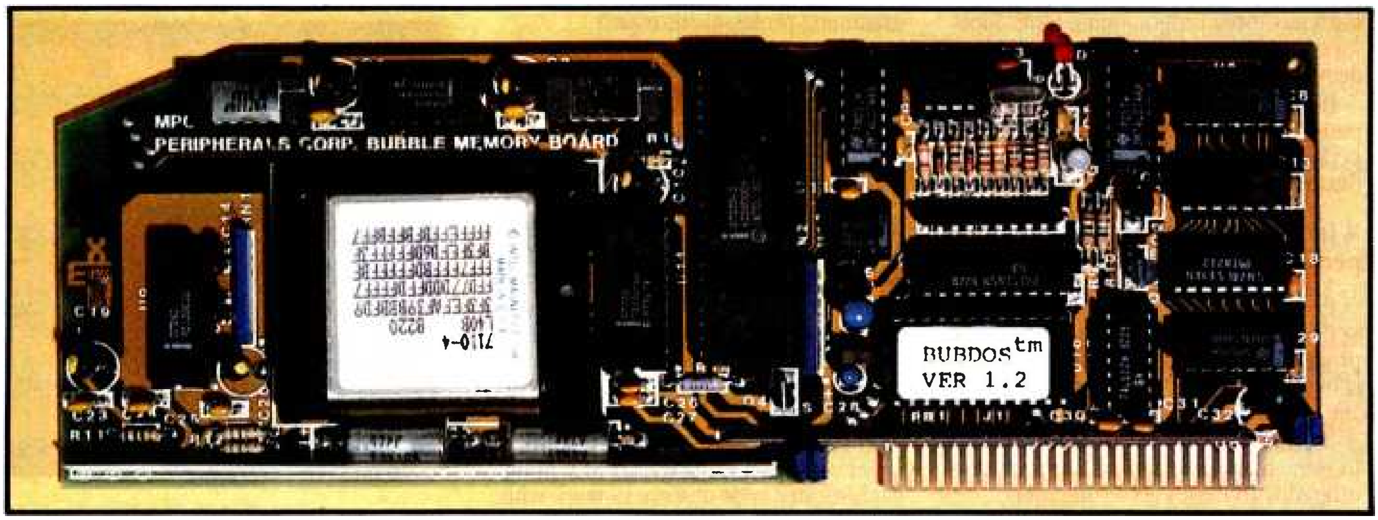

Photo 1: *The BUBDISK for the Apple II. The large square chip is Intel's bubble-memory chip, which holds 128K bytes of nonvolatile data.*

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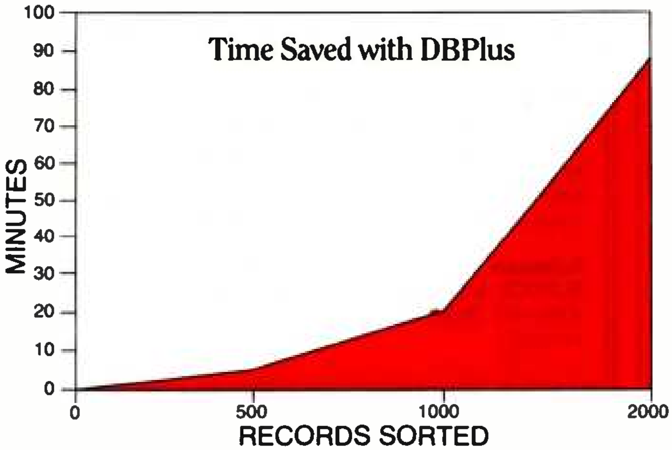

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Software
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Two years for parts and labor

Audience
Any Apple owner wishing to reduce waiting time when using floppy disks

module designed to plug into the Apple II. The difference between the BUBDISK and other expansion boards is MPC's use of an Intel 7110-4 bubble-memory device (see photo 1). For those of you not familiar with bubble memory, one of its main attractions is its nonvolatility. If you turn off the computer or lose power, whatever was stored in bubble memory is not lost. You thus end up with an added measure of protection against disaster.

Installation of the BUBDISK is extremely simple. After turning off power to the Apple and opening the top of the computer, you must ground yourself by touching the power-supply case. You then remove the disk-controller card from its normal slot 6 position, put the controller in slot 5, and plug the BUBDISK card into slot 6 of the Apple. Just button up the Apple and you are done.

To check everything out, when you turn on the Apple you should hear a few clicks from the speaker and the BUBDISK greeting should appear on the screen. If you don't get the BUBDISK greeting, simply insert the BUBDOS disk into your standard disk drive, boot the disk from slot 5, and initialize the BUBDISK in slot 6. The DOS on MPC's BUBDOS disk is a patched version of the standard Apple 3.3 DOS. In fact, the BUBDOS is actually a version of Diversi-DOS from DSR Inc., which operates faster than the Apple 3.3 DOS.

After you have the BUBDISK up and running, you have a real treat in store. You can use the Copy program on the Apple System Master to copy a whole floppy disk into bubble memory from the drive in slot 5 (or just move over selected files with the FID program). Then run your application program. You will not believe the difference in speed! You have a data-transfer rate of 12.5K bytes per second.

To see how much difference the BUBDISK makes, I tried several representative programs Apple users might

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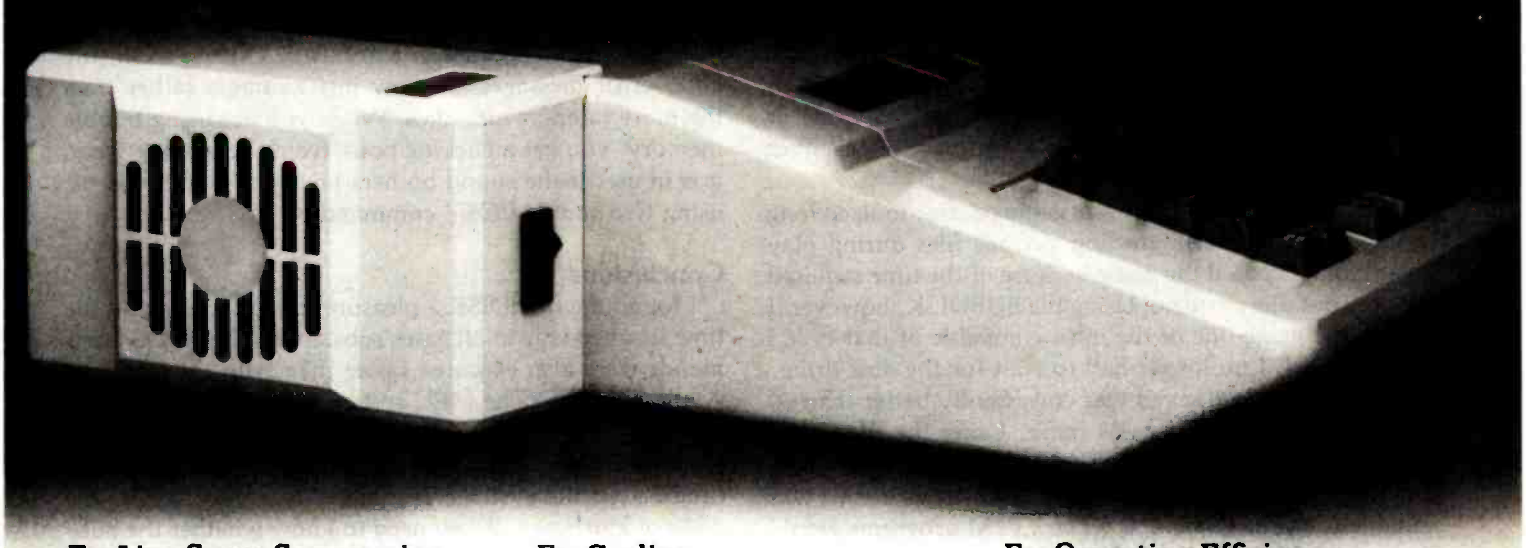
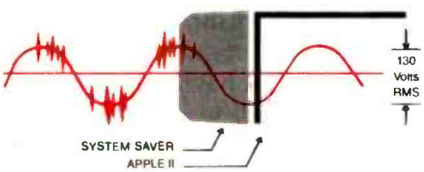
The most important peripheral for your Apple II and IIe.



For Line Surge Suppression

The SYSTEM SAVER provides essential protection to hardware and data from dangerous power surges and spikes.

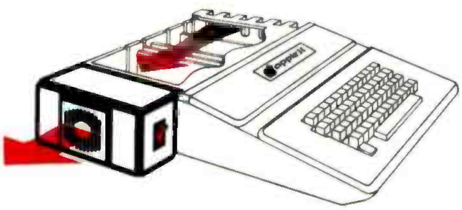


By connecting the Apple II power input through the SYSTEM SAVER, power is controlled in two ways: 1) Dangerous voltage spikes are clipped off at a safe 130 Volts RMS/175 Volts dc level. 2) High frequency noise is smoothed out before reaching the Apple II. A PI type filter attenuates common mode noise signals by a minimum of 30 dB from 600 khz to 20 mhz, with a maximum attenuation of 50 dB.

For Cooling

As soon as you add 80 columns or more memory to your Apple II you need SYSTEM SAVER.

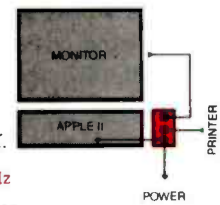
Today's advanced peripheral cards generate more heat. In addition, the cards block any natural air flow through the Apple II creating high temperature conditions that substantially reduce the life of the cards and the computer itself.



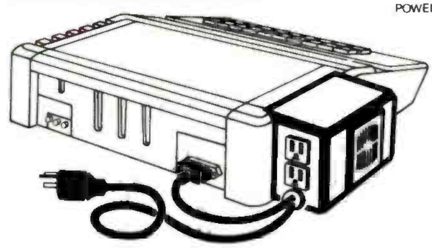
SYSTEM SAVER provides correct cooling. An efficient, quiet fan draws fresh air across the mother board, over the power supply and out the side ventilation slots.

For Operating Efficiency

SYSTEM SAVER contains two switched power outlets. As shown in the diagram, the SYSTEM SAVER efficiently organizes your system so that one convenient, front mounted power switch controls SYSTEM SAVER, Apple II, monitor and printer.



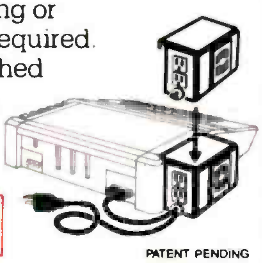
Available in 220/240 Volt. 50 Hz



The heavy duty switch has a pilot light to alert when system is on. You'll never use the Apple power switch again!

Easy Installation

Just clips on.
No mounting or hardware required.
Color matched to Apple II.



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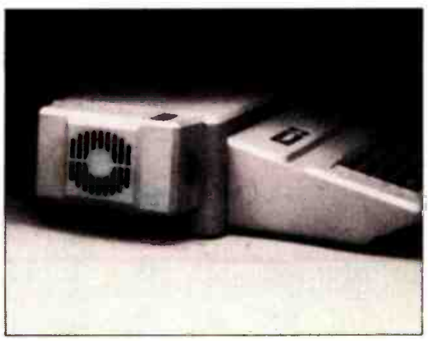
Compatible with Apple Stand



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have. As an example, using the Home Accountant program from Continental Software, I was able to save 10 seconds on each read/write operation using the BUBDISK. The particular files I was using took slightly more than 18 seconds to read or write using a standard disk drive, but only 8 seconds with the BUBDISK. I found the same sort of time savings on all the programs I tried (programs will give different time savings depending on how many different files you have to move and their sizes). It was like going to a disk system from cassettes all over again.

In one case, a computer war game on disk took so long going back and forth reading various files during play that I almost hated the game because of the time required to play out one scenario. Using the BUBDISK, however, I found the game one of the most enjoyable of that type I have played. I no longer had to wait for the disk drive.

I found the time saved was consistently better than 50 percent—and in some cases more. Using the BUBDISK with Apple Pascal also gave similar time savings over the standard disk system. At the time this was written, I was unable to determine if and when CP/M programs would be compatible with the BUBDISK.

Another application for the BUBDISK is a "disk-less" Apple. For example, you can load the BUBDISK with BUBDOS, a word processor, and a communications program. Then you can disconnect the disk drive and use the Apple (with a small monitor and modem) as a fairly portable workstation.

I experienced only one problem area while using the BUBDISK, and it has nothing to do with this outstanding product. In many cases, I couldn't use this new tool because of the copy-protection measures used by manufacturers on their programs. These copy-protection measures made it impossible to read these programs into the BUBDISK. In several cases, I couldn't even read the data disk into bubble memory because the data disks were also modified as part of the copy protection. If for no other reason than to be able to use products like the MPC system, users should insist that their application programs not be copy protected.

Some minor notes. Because a standard Apple 3.3 DOS disk holds 143K bytes, with DOS loaded on the first three tracks, and BUBDISK holds only 128K bytes, something has to be sacrificed. I never had any problems in this area, however. If I needed all the bubble memory for data, I deleted the DOS from the BUBDISK and used the DOS from a BUBDOS disk in the disk drive.

Additionally, because you are using Diversi-DOS, the DOS error messages are now just numbers rather than the more familiar messages. When you are using bubble memory, you get a clicking noise from the speaker when it is in use. If the sound bothers you, you can turn it off using two simple POKE commands.

Conclusions

I found the BUBDISK a pleasure to work with, and the time it saved was in all cases substantial. The DOS commands were also executed faster than with the standard Apple 3.3 DOS. The MPC system is simple and reliable. Automatic error-correction circuitry is built into the system. I didn't experience any data errors during the time I used the system. The board is a very well made piece of hardware. If you need to know whether the bubble is operating, you can look at the board; the board's LED (light-emitting diode) comes on when the bubble is being used. Some users may find the manuals provided with the system a little skimpy, but there really isn't much involved in operating the BUBDISK. Just act as if it were a standard disk drive and you should have no problems. It is also noteworthy that the BUBDISK comes with a two-year (parts and labor) warranty.

If you have ever been frustrated at having to wait while your Apple shuffled back and forth to a disk drive for data, you can eliminate those frustrations very quickly by using a BUBDISK.■

About the Author

Peter Callamaras, an officer in the Air Force, can be reached at AFIT/LS, Wright-Patterson AFB, OH 45433. The recipient of degrees in computer technology and biological sciences, he is currently working on a master's degree in systems management. He has been interested in computers since 1966 and used to be the service department manager of a computer store.

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Commodore 64

Photo 1: *The Commodore 64 and 1541 disk drive. Inset shows rear view of the 64. From left to right, the cartridge slot for game or program cartridges; channel selector and TV output connector; the direct audio and video connector; serial port for disk drives or a printer; cassette interface; and the user port for peripherals such as the VICmodem.*

by Stan Wszola

At first glance it's possible to mistake the Commodore 64 for its predecessor—externally the 64 looks like a tan VIC-20. But the similarities stop with the case design and keyboard layout (see photo 1). The 64 is a completely different machine. It has features, such as sprite graphics and high-quality sound, not to be found on the VIC-20. A full-featured and versatile machine, the 64 retails for $595. At that price it promises to be one of the hottest contenders in the under-$1000 personal computer market.

The Commodore 64 is based on MOS Technology's 6510 8-bit microprocessor, which uses the same instruction set as the 6502 (the heart of the VIC-20), but which includes eight additional input/output (I/O) lines used in the 64 for memory management; they control bank switching between the internal ROM, an external ROM cartridge, or an I/O device, which allows any of these to appear to occupy a certain portion of the processor's address space. This bank switching gives the 64 a total of 84K bytes of memory: 20K bytes of read-only memory (ROM) and 64K bytes of random-access read/write memory (RAM). BASIC programs can access 39K bytes of RAM; machine-language programs (figure 1) can access 52K bytes of RAM.

The 64 can be expanded in a variety of ways. At the back of the case is a slot for program or game cartridges (see photo 1 inset). On the right side are two ports for joysticks or game paddles and a socket to plug in the outboard power supply. The 64 has a built-in RF (radio-frequency) modulator so you can use your TV as a video monitor. All you have to do is make a simple connection to the antenna terminals; a switch on the computer lets you view the output on channel 3 or 4.

The 64 has connections for audio input and output and a connection that provides a composite video signal and direct audio for driving a video monitor. Also, the 64 contains a serial port for connecting a disk drive or printer, a cassette-recorder interface, and a user port for peripherals such as the VICmodem. It would be nice, however, if the 64 had real RS-232C and parallel printer ports so you could use someone else's peripherals. Even to load a cassette tape you must buy Commodore's cassette recorder.

The 6567 Video Interface Chip (also referred to as the VIC-II chip) controls graphics. It gives the Commodore 64 a 40-column by 25-line text display with 16 text colors and its own set of graphics characters. The chip can produce a 320- by 200-dot high-resolution display with up to 255 combinations of foreground and background colors and support up to eight sprites (movable object blocks) on the screen at one time.

The Commodore 64 has the 6581 Sound Interface Device (SID) chip, which produces music and sound effects covering a nine-octave range and generates three voices simultaneously. You can control all aspects of the sound generation via POKE instructions in BASIC. The volume, waveform, attack, decay, sustain, release, duration, and note selection are all under software control.

Such an inventory of standard features is impressive at $595 (some discount houses advertise it for as little as $399). As an added benefit, the 64 can run some PET software. And the optional Z80 CP/M cartridge gives you access to a potentially large base of well-established software that includes word-processing, electronic-spreadsheet, and communications programs.

At a Glance

Name: Commodore 64

Manufacturer
Commodore Business Machines Inc.
Computer Systems Division
The Meadows
487 Devon Park Rd.
Wayne, PA 19087
(215) 687-9750

Price
$595

Dimensions
16 by 8 by 3 inches

Processor
6510 (a 6502-compatible processor with 8 additional I/O lines)

Memory
20K bytes of ROM
64K bytes of RAM

Data Storage
VIC-1530 Datassette audio-cassette recorder; VIC-1541 single-sided single-density floppy-disk drive

Languages
Commodore BASIC V2.0
Optional Z80 CP/M cartridge available

Documentation
Commodore 64 User's Guide, 167 pages
Optional Programmer's Reference Guide, 487 pages

Audience
Any computer buyer who wants an introductory machine with BASIC, color graphics, and sound

First Touch

Having worked with the original PET 2001 back in 1978 and experienced the limitations of its keyboard, I found it a pleasure to sit down at the Commodore 64. Its full-size 66-key keyboard includes four special-function user-programmable keys. The graphics characters and special functions that are accessible from the keyboard are displayed on the sides of the keys.

I have no trouble touch-typing on the Commodore 64. The layout differs only slightly from that of the Selectric. Fast typists will appreciate the type-ahead buffer that holds 10 keystrokes. Only the cursor, space-bar, and Insert/Delete keys repeat automatically when held down. A minor annoyance is that there are only two keys for cursor control. To move the cursor right or down, you simply press the appropriate keys but to move the cursor left or up you must press the Shift key in addition to the appropriate key. This is an awkward arrangement for those used to four separate cursor-control keys. In the graphics/text mode, pressing the shift key and any alphabetic key will give you the graphics character shown on the right side of the key. By pressing the Commodore key and an alphabetic key, you'll get the graphics character shown on the left side of the key. PET owners have long used this arrangement to produce graphics from within BASIC programs.

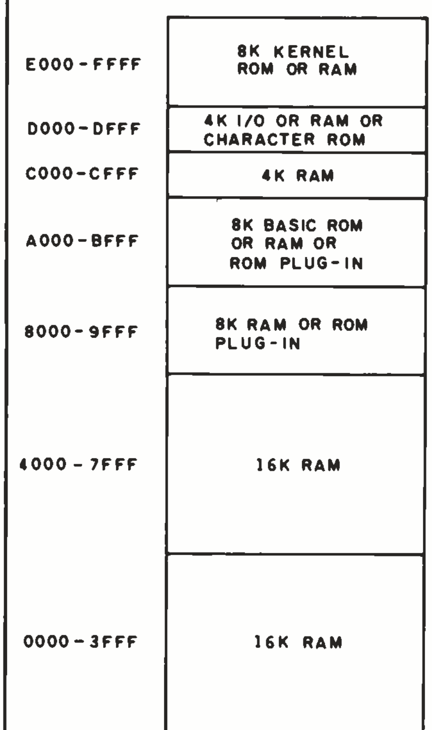

Figure 1: *Memory map of the Commodore 64. This is the standard configuration. Both the Kernal ROM and BASIC may be switched out of memory, leaving 64K bytes of RAM.*

Memory Management

The 64 uses the 6510's eight additional I/O lines as a memory-mapped control port. The eight lines are treated as one memory location and reside at address 0001; address 0000 is a control register that determines the direction of data flow on the lines. By sending a 0 to the least significant bit (called bit 0) of address 0001, you can replace the BASIC ROM with RAM, a process known as bank switching. Sending a 0 to bit 1 of address 0001 eliminates the Kernal ROM that contains the 64's operating system.

Bank switching explains how the 64 can run CP/M. By using bank switching to replace the ROMs with RAM, the system is left with an uncluttered 64K bytes of memory into which you can load CP/M. Of course, this also gives you the opportunity to design your own operating system.

Graphics

The Commodore 64 provides a variety of graphics modes. You use the POKE command to enter values into the 47 control registers of the VIC-II chip to set the various graphics modes. Although using POKE commands makes for awkward programming, it allows for fast-action graphics in BASIC.

The VIC-II chip is designed to access 16K bytes of memory, which means that, for example, it can be programmed to access the character-generator ROM or any 16K-byte bank in memory. By using POKE and PEEK instructions to enter values into port A of the 6526 Complex Interface Adapter Chip #2, you can control which bank of memory the VIC-II chip uses. This setup frees the 6510 microprocessor from the time-consuming work of controlling all the graphics and gives programmers a flexible tool to use in developing creative graphics.

When you first turn on the Commodore 64 it's in a graphics/text mode showing a 40-column by 25-line screen composed of two 256-character sets. Each character in the sets is made from an 8 by 8 matrix; the sets contain uppercase and lowercase letters, punctuation marks, graphics, and other special symbols and include

Photo 2: *Sample screen display showing the 16 colors available.*

normal and reverse-video characters. The 40 by 25 display format was chosen because most Commodore 64s will be used with home television sets that have a limited bandwidth for graphics. (An 80-column by 24-line adapter, the Video Pak 80, is available from the Data 20 Corp., Suite B10, 23011 Moulton Parkway, Laguna Hills, CA 92653.)

The screen initially displays dark blue characters on a light blue background. By pressing one of the number keys and either the Control or Commodore key, you can change the display characters to any of 16 different colors (photo 2). The background and border colors can also be changed by using POKE commands. For example, POKE 53280,*x* and POKE 53281,*y* (where *x* and *y* are the color numbers) alter the border and background screen colors, respectively. Screen colors may be restored to the default values by pressing the Run/Stop and Restore keys simultaneously.

In standard character mode, each of the 1000 character positions on the standard screen has a corresponding byte in memory. This is known as a memory-mapped display. By using POKE commands, you can enter an 8-bit number into any of the character locations in memory; the Commodore 64's character-generating ROM will make the correct pattern of dots appear at the corresponding screen location.

You can create a custom character set by instructing the system to use a section of RAM in place of the character-generating ROM. Then, by turning dots on or off in the 8 by 8 matrix that represents a character image (actually an 8-byte block in memory) you can design your own character set for foreign languages and technical or scientific applications.

The 64's memory-mapped display lets you use bit-mapped graphics. In this mode, each dot on the screen may also be represented by a bit in memory. Because each character is composed of an 8-byte block, the bit-mapping of the screen's 1000 blocks must contain 8000 bytes of memory, or 640,000 bits. Each of these bits can be turned on or off under program control.

The Commodore 64's high-resolution bit-mapped screen measures 320 dots horizontally by 200 dots vertically and gives you a choice of two colors for each 8- by 8-dot character block. A multicolor bit-mapped mode allows a choice of eight different colors for each block, but the resolution is reduced to 160 by 200 dots.

Sprites

Sprites, which are also referred to as movable object blocks, are similar to the player/missile graphics used on the Atari 400/800 computers. A sprite is a user-definable character composed of 24 horizontal by 21 vertical dots (photo 3). Sprites, which are generated and controlled by the VIC-II chip, can be sculpted into any shape, given any of 16 colors, combined with any other graphics mode, and made to move about the screen. As such they are ideal for use in arcade-type games. Independent of normal graphics, they can be used from within a BASIC program. Each sprite has its own 63-byte location in memory and its own position and color registers.

You can activate a sprite by entering a 1 for the appropriate bit in the sprite register of the VIC-II chip. You then program its shape, enter a value for its color, and set its position on the screen. You define each movement by providing a new set of Cartesian coordinates for its position.

You can enlarge a sprite to twice its original dimensions, but its resolution drops when it is expanded to the max-

Text continued on page 239

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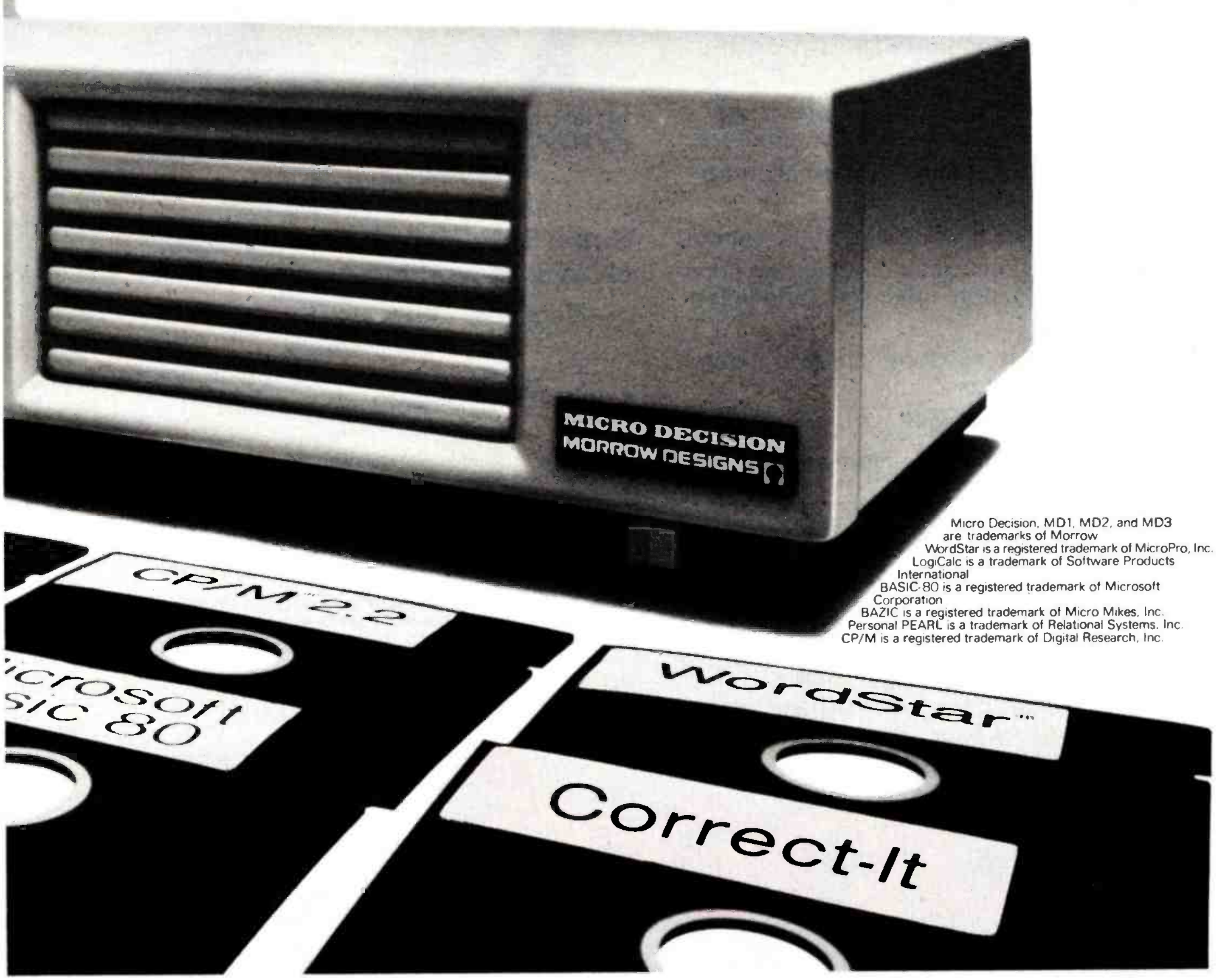

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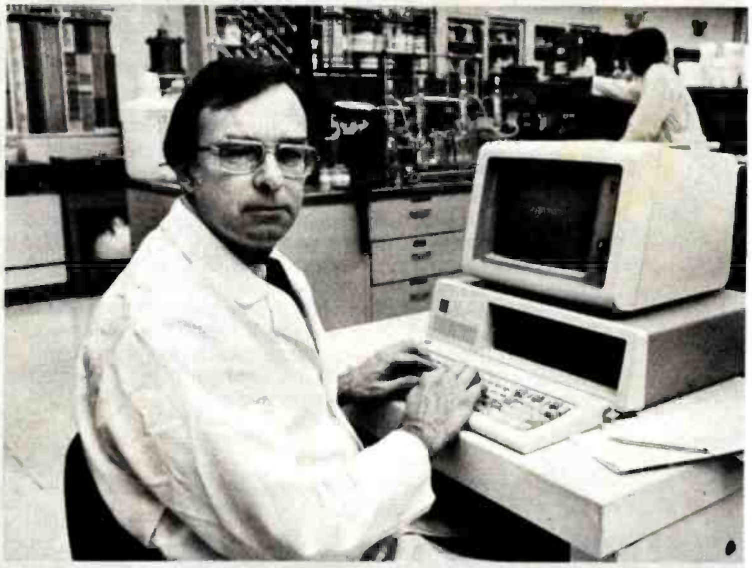

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FIRST IN SOFTWARE TECHNOLOGY P.O.Box 1628 Champaign, IL 61820 (217) 359-2112 Telex 270365 imum size of 12 by 21 dot pairs. The resolution also drops when you use the multicolor mode (up to four colors for each sprite).

Each sprite has a display priority. When sprites cross paths, one appears to pass behind the other. Sprite 1, for example, has a higher priority than sprite 6. If their positions intersect, sprite 1 appears to pass over sprite 6. This can give a three-dimensional effect for games and graphics (photo 4).

The VIC-II chip can detect collisions between sprites or between sprites and background data—a handy feature for game designers. You can use PEEK commands to examine the sprite-to-sprite or sprite-to-data collision registers in the VIC-II chip. Each sprite has a bit in this register; if that bit is a 1, that sprite is involved in a collision. The collision-detection feature simplifies the programming required for interactive arcade-type games.

Sound and Music

The Commodore 64 gives you something rare in a microcomputer—good sound. It uses the 6581 SID chip, a true music synthesizer that has been interfaced to a computer. The quality of the sound has to be heard to be believed. At first, I had used the 64 with a color television and was surprised to get good sound considering that the signal had been run through the RF modulator and then demodulated by the TV receiver. When I heard the monophonic direct audio output amplified by my stereo system, I was even more impressed.

Each of the SID's three voices can be programmed to sound like a different musical instrument; you have a choice of organ, piano, harpsichord, woodwind and brass instruments, and special sound effects. Because the sound generation is under direct program control, you can custom design a sound to your liking.

Separate tone and envelope generators on the SID chip produce each voice over a nine-octave range. You can program the SID chip using POKE commands to memory locations 54272 through 54296.

To understand how the Commodore 64 produces sound, consider the following program that uses one voice to produce the note C in the fourth octave:

```
 5 REM SAMPLE SOUND PROGRAM
10 POKE 54296,15
20 POKE 54277,64
30 POKE 54278,130
40 POKE 54276,17
50 POKE 54273,17:POKE 54272,37
60 FOR T=1 TO 250:NEXT
70 POKE 54276,0:POKE 54277,0:
   POKE 54278,0
```

To begin, enter a 15 into location 54296 (line 10). This sets the volume at the highest level. Line 20 starts to define the envelope of the note. The envelope, a way of shaping the sound, defines the rate at which the amplitude of the note attacks (or rises) to its maximum volume, decays (or drops) in volume, the length of time it will be sustained, and finally the point at which it is released. Each

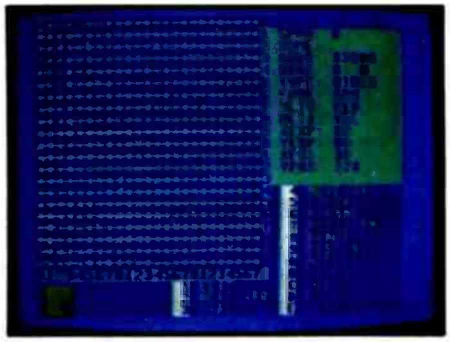

Photo 3: *Sprite editor display. Defining a sprite is just a matter of turning dots on or off. The actual size of the sprite is shown in the lower left corner.*

Photo 4: *Sprite Priorities. In this still shot from an animated sequence, some of the sprites appear to pass in front of or behind the mountain. All of the sprites on the screen have different priorities to give the effect in three dimensions.*

musical instrument has a distinctive attack/decay/sustain/release (ADSR) envelope. If you look at an oscilloscope display of a note played by a particular instrument, you can see the envelope for that instrument.

Line 20 sets a high attack rate and a low decay rate. (The number is broken into 8 bits: the high-order bits set the attack, while the low-order bits set the decay.) That value, 64, is entered into location 54277. Line 30 enters the sustain/release rate, which lets you prolong the note. Again, as in line 20, the two values are represented by one number. The number 128 produces a long sustain and a short release.

Line 40 sets the waveform of the note in one of four shapes: sawtooth, triangle, pulse, and white noise. Sawtooth waves contain a lot of harmonics and are good for simulating horns or string instruments. Triangle waves produce flute-like sounds. Pulse waves can simulate many different sounds depending on the pulse width. A square wave will produce a woodwind sound similar to a clarinet. A very narrow pulse will produce a sound similar to an oboe or bassoon. White noise is used for producing untuned sounds such as percussion instruments. Line 40 uses a triangle waveform.

Line 50 performs two functions: the two memory locations 54273 and 54272 determine the voice to be used, while the values 17 and 37 determine the note to be played (in this case a quarter note). Finally, line 70 clears all previously used memory locations in preparation for playing another note.

The Commodore 64 has a few more musical tricks up its sleeve: the harmonic content of a note can be altered by filtering. The SID chip has three different filters: high-pass, low-pass, and bandpass. As you might expect, the high-pass filter allows only frequencies above a certain value to get through, the low-pass filter allows only frequencies below a certain value to get through, and the bandpass filter lets through only frequencies of a specified range. As mentioned previously, generating and altering sound is done with POKE commands. The filters give you another method of shaping the sound.

The Commodore 64 has an audio input line. You can take an audio signal from an electric guitar, for example, and process it through the 64. There the signal can be filtered or combined with one or more voices to create a unique sound. In effect, the 64 is both a synthesizer and processor. Using POKE commands is somewhat distracting but the 64's version of BASIC does not have any commands for controlling sound directly from within a BASIC program.

BASIC

It's a pity Commodore saddled such a fine computer with its inadequate Commodore BASIC 2.0. An 8K-byte interpreted BASIC, it is a subset of the standard Microsoft BASIC and uses its own commands for file handling and I/O. Most BASIC instructions can be abbreviated to just two letters. A program written using this abbreviated technique displays BASIC commands as a letter and graphics symbol. A Commodore 64 program may be difficult to understand unless you've memorized all the abbreviations. Program lines are limited to 80 characters. Only the first two letters in a variable name are used. Obviously, Commodore feels that most home users will be running prepackaged software—there is no provision for using graphics (or sound as mentioned above) from within a BASIC program except by means of POKE commands.

The one bright point in programming the Commodore 64 is its very powerful screen editor. Once you have written a BASIC program, you can move your cursor through the program and make corrections by typing over the previously entered characters. A modified line can be inserted into a program by simply positioning the cursor on that line and pressing the Enter key. You can use the Insert/Delete key to add or remove characters from a line.

In addition, the editor has a unique "quote mode." If the cursor is positioned to the right of an odd number of quote marks in a program line, you can enter cursor control and color control codes within strings. When the text within the string is printed on the screen, the cursor and color con-

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trol codes automatically perform their tasks. This gives you another way to control screen displays.

Because the Commodore 64's version of BASIC makes extensive use of graphics and reverse-letter characters, you might have a problem when you want to print a program. Most printers can't handle Commodore graphics. Only the VIC-1525 Graphic Printer is designed explicitly for use with the Commodore 64. (If you are interested in connecting other printers to the Commodore 64, see "The Enhanced VIC-20, Part 3: Interfacing an MX-80 Printer," by Joel Swank, April 1983 BYTE, page 260.)

Data Storage

The Commodore 64 uses the VIC-1530 Datassette cassette recorder for data storage. The Datassette is adequate for someone who wants to load an occasional game or use a cassette-based word-processing program. But for users who don't like the limitations of cassette storage, Commodore offers the VIC-1541 disk drive, a smart peripheral with its own 6502 microprocessor (to control I/O), 2K bytes of RAM, and a disk operating system (DOS) in 16K bytes of ROM. The drive uses standard 5¼-inch single-density single-sided floppy disks for a storage capacity of 170K bytes per formatted disk.

Having the DOS in ROM simplifies disk operations and saves computer memory and space on the disk.

Having the DOS in ROM simplifies disk operations and saves both the computer's memory and space on the disk. This means that every disk contains data only and that you never have to worry about accidentally destroying the DOS. Of course, you'll have to use Commodore's DOS unless you change the ROM.

The DOS commands are extensions of the same commands used with the Datassette recorder. For example, to load a disk program called SAMPLE, you would type the command

LOAD "SAMPLE",8

The 8 at the end of the command is the device number of the disk drive. This number is hard-wired into the disk drive, but it can be changed temporarily by a software command.

You must load a directory of the disk into the Commodore 64 as if it were a BASIC program. You use the command

LOAD "$",8

Then type LIST to see the directory display. The disk-drive manual lists some utility programs that will produce a directory with a little more ease. Or you can use the WEDGE program, included with the 1541 disk drive, that will allow you to use shorthand commands to load and save files, see a directory, etc. However, this is still an awkward way to access a disk when compared to commands used with disk operating systems such as TRSDOS or CP/M.

Files

The 64 supports sequential, random, and relative disk files. Sequential files are recorded serially on the disk as if they were being saved on a cassette tape. Random-access files are treated as one (or more) 256-byte blocks of data, with each block saved in a single disk sector. Relative files are organized into records that can be read or replaced within a file. They make use of what Commodore calls "side sectors," actually a series of indexes that act as pointers to the particular sectors associated with the file. Using this method, one file fills an entire disk.

The disk drive uses the 64's serial port. Because data is sent to the disk one bit at a time, disk operation is very slow. I found it to be even slower than the Atari 810 drive. Also, Commodore's method of writing 256-byte blocks of data to the internal

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RAM and then finally writing the data to disk slows down disk operation. Up to five drives may be chained together and used simultaneously. Disks created on the 1540 drive and the older CBM 4040 can be read by the 1541 drive.

Documentation

The *User's Guide*, which is heavy on programming, is a good introduction to the 64's features. It has all the essential information required for working with BASIC, graphics, and sound. But it doesn't contain enough information about working with peripherals or connecting the computer to an audio system or video monitor.

The optional *Programmer's Reference Guide*, a 487-page informative book, is essential for anyone serious about programming the 64. It covers the same material as does the *User's Guide*, but in greater depth and detail. Many sample programs are listed and discussed that help to explain the operation of the Commodore 64's special features. One section gives the specifications for each LSI (large-scale integration) chip used in the computer; it also includes a schematic of the Commodore 64, but it's not complete enough to use as a repair guide.

My only complaint about the *Reference Guide* is the lack of information on using disk drives for data storage. Apparently Commodore believes that the manual included with the 1541 is sufficient (it's not), and that if you don't own a drive, you don't need the information. Another not-so-surprising omission is the lack of information on using CP/M with the Commodore 64. It was merely mentioned in several pages. I expect more complete documentation to be included with the plug-in Z80 cartridge.

A great many PET BASIC 2.0 programs can be easily transferred to the 64, and emulator programs give you even more software.

Software

The availability of software can make or break a computer. In this respect, Commodore 64 owners are fortunate. A great many PET BASIC 2.0 programs can be easily transferred to the 64. And Commodore offers the PET Emulator program that lets you load a substantial portion of PET programs into the 64. It converts memory addresses used with the PET to those used with the 64.

You can get also an Apple II emulator, a combination of software and hardware available from Home Computer Services, 2028 West Camelback Rd., Phoenix, AZ 85015. The company says the emulator allows you to load and run Apple II programs with your Commodore 64. I'll reserve judgment until I have a chance to work with the product.

The Commodore software catalog for the 64 has a listing for an Easydisk

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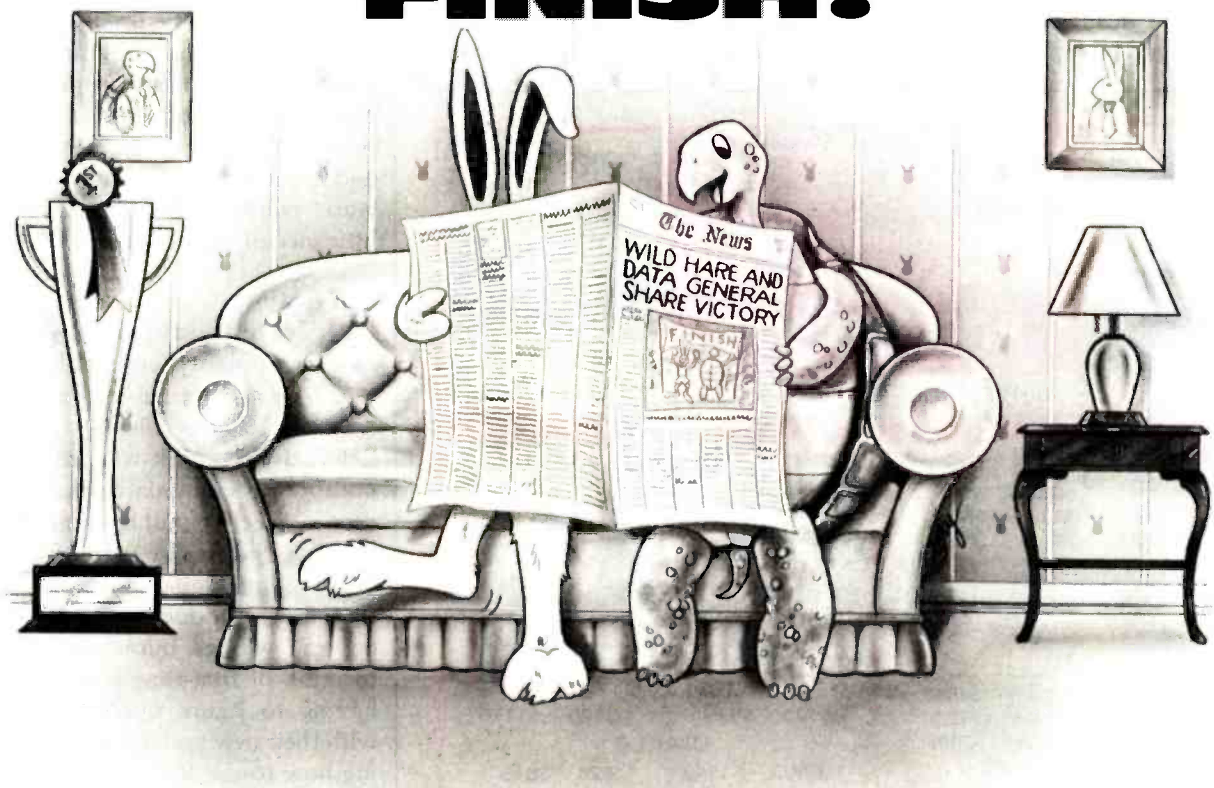

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64, a collection of utility programs and editors for sound and graphics, and Easygraphics 64, a utility program that extends BASIC by giving you several simple commands to control sound and graphics without the use of POKE commands. These programs were not available in April but should be by the time you read this.

Although the 64 is essentially a home computer, Commodore is offering several business-oriented software packages for it. Designated as part of the "Easy" group, they include Easycalc 64, an electronic spreadsheet program; Easyfile 64 for database management; Easyplot 64 for business graphics; and Easyschedule 64, a time-scheduling program.

Considering the sophistication of the 64's graphics, the one package I most want to try is Logo. As described by Commodore, its version of Logo will be similar to Terrapin Logo for the Apple II, except that it will take full advantage of sprite graphics and color. Logo on the Commodore 64 should be a natural for schools. (The August 1982 BYTE was devoted to the Logo language.)

Speaking of schools, Commodore has announced its version of PILOT, a language designed specifically for use in education. Commodore claims that its PILOT is based on a "common" version of the language. One hopes that this will allow many existing programs to be used with the 64.

Of course, the programs I have mentioned here represent just a small portion of the software available for the 64. A quick glance through BYTE and other magazines shows that software publishers recognize the significance of the machine.

Complaints

My biggest complaint is with Commodore's quality control. I had to return two computers before I got one that didn't have display problems. Evidently, the fault was in the video output or RF modulator circuitry. If I used a defective unit for more than 15 minutes, the display on the TV would begin to break up and distort. I know that early production models often have a few bugs, but it's discouraging to think of first-time computer users having to figure out what's wrong with their new system on top of learning how to use it.

Conclusions

The Commodore 64 is a good introductory machine. It has something for almost every type of user. Its range of features make it equally suitable for me and my 5-year-old daughter to use. The color and graphics make games and educational software interesting enough to hold a child's attention, yet it has enough sophisticated features to allow me to do productive work such as word processing and home finances.

With the right price, plenty of available software, and numerous desirable features, the Commodore 64 is an impressive machine. ■

About the Author

Stan Wszola is a technical editor of BYTE.

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The Strobe Plotting System

by Jack Bishop

Business and scientific reports are not light reading. Long ago someone found that graphs and charts are less boring and more informative than long lists of numbers. This discovery was enthusiastically received by readers but not by authors, who were faced with choosing the format and plotting each point laboriously for every graph. As a result, the sales of graph paper must have soared as authors drew and redrew to make a graph that truly told a story. Artisans labored over each point, working with sheets of paper, tape, and a razor blade to improve the quality of the product. A chart or two per day was a reasonable standard of productivity.

Several years ago, powerful graphing program packages appeared for mainframe computers (e.g., Plot 10, Displa, Telegraph, SAS/Graph). With these packages, authors could create complex graphs quickly, easily, and accurately. They were still faced with spending $15,000 for a computer system to produce the graphs, but the quality and quantity of output justified the cost for many large companies.

The advent of the microcomputer with its ability to dump graphics to a low-cost dot-matrix printer or plotter brings efficient graphing power within the price range of a whole new set of users. The quality may fall short of the multicolor design and precise positioning available on the more expensive plotters but is far better than the crude, labor-intensive alternatives available to this point. The convenience of the new microcomputer software more than compensates for the lack of flexibility and power you get from a $50,000 plotting package. In fact, the plotting packages available for mainframes and timesharing systems could be improved with some of the convenient features (e.g., simple menu operation and heavy use of defaults for automatic scaling, labeling, etc.) found on inexpensive microcomputer plotting systems such as the Strobe Model 100 Computer Graphics Plotter.

Getting Started

The Strobe System consists of a drum plotter and software (graphing packages) for creating the graphs.

The Strobe Plotter is a unit about half the size of an Apple II Plus (see photo 1). The 20 inches or so of ribbon cable connecting the plotter to the Apple interface card gives some options on where the machine can be set. (By the time you configure your system with any plotter, you probably will be forced to add table space to your work area.) The power switch is behind the right side of the machine, and you can easily reach it, but a front placement wouldn't hurt at all.

The installation of the interface card in the Apple is relatively simple, provided you have the requisite empty slot. If you are like me, by the time you get around to the purchase of a plotter, empty slots are at as much of a premium as is table space. The choice of the slot is not as casual as might be expected. Most graphics software requires the plotter interface to be in a particular slot location; some programs are very particular. Check the software you plan to use to drive the plotter, and you may find that you have to put the Strobe interface in a slot that is dedicated to other uses most of the time. (For example, PFS:Graph, from Software Publishing Company, expects to see the plotter in slot 2 and will brook no substitutions.) With my system a bit of card swapping was necessary, and some users may find that the interface card will have to be shuffled around every time a graph-making session is scheduled. Besides considering swapping an annoyance, I have concern for the life of an interface card pulled and inserted frequently.

The Strobe software enabled me to put the interface card in any slot, provided I ran the Configure program to set up the proper slot. When I ran the first program in the set of software, the Configure program ran fine. When I ran the second program in the set, I was puzzled to find

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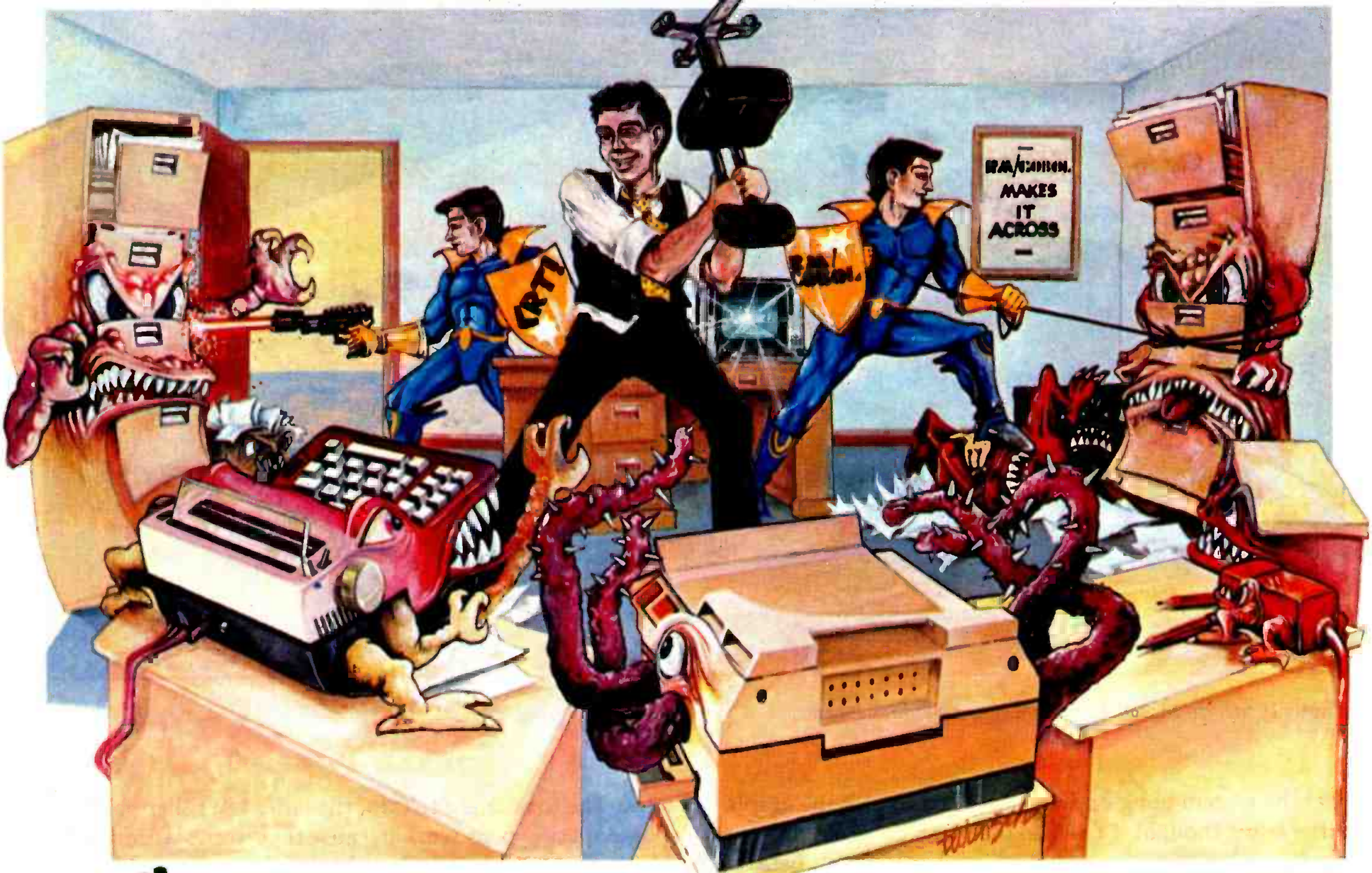

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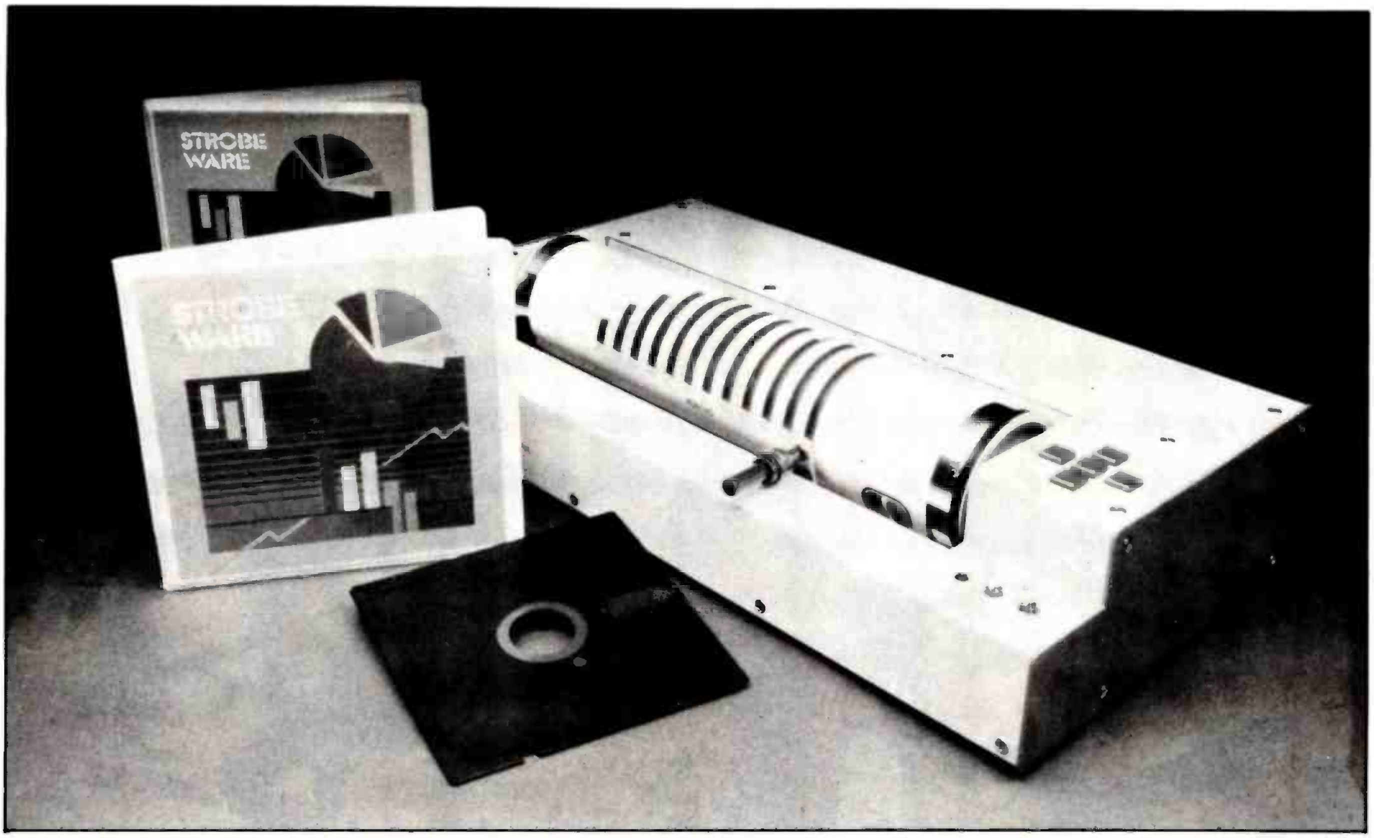

Photo 1: *Strobe Model 100 Computer Graphics Plotter.*

that the system hung up when I started to plot the graph. After some thought, I realized that each program must be configured separately; no interprogram learning here.

The Basics

Paper loading involves sliding a sheet of paper under a bar, rotating the drum, and sliding the free end of the paper under the other side of the same bar. While the first few tries were a bit awkward, with practice I fitted the paper smoothly around the drum in a few seconds. The hardest part is remembering to turn the motor release switch. (The Release switch is labeled ON —surely a less confusing labeling is possible. How about LOAD in place of ON and RUN in place of OFF, and leave the technically correct and practically confusing labeling to the engineers in the crowd.)

The more I used the Strobe, the less satisfied I was with the procedure for securing the paper. Several graphs were spoiled when the action of the pen gradually worked the paper free from its restraints. This caused unwanted lines when the pen failed to clear the loose paper as it moved across the drum to plot a desired line. At other times, the loose paper was too unstable to make the lower part of the graph, and title or x-axis labels became unreadable. If I could redesign the Strobe, I would experiment to see if a small static charge could be drawn on the drum to help hold the paper in place. Or I would find some adhesive compound to put on the drum to overcome this problem.

The Strobe uses either Pilot Razor Point or Berol Spree pens. The former is a felt tip, the latter is a roller ball pen. These specific pens work because their soft plastic shanks are the right size to be force-threaded into the pen holder. Inserting a pen is no more complicated than screwing it into the threaded bushing on the front of the plotter. I feared that I might break something, so I didn't thread the pen in far enough on my first try. Result: a mostly clean sheet of paper. Screwing up my courage and screwing the pen in tightly (3¾ turns by my count) produced a decent-quality line; judge the figures that accompany this article for your assessment.

Multicolor graphs are possible only if the software you use can stop and allow time for a pen change. You could get around this limitation by producing several different graphs, each with only one color, and overprinting each, but I wouldn't want to try!

The Strobe instructions specify that the pen be mounted before the graph is formed. After trying that, I adopted a different procedure. I'd recommend not mounting the pen until the graph is to be printed. The pen point dries out during the construction of the graph, and a poor-quality line is produced for the first few inches of tracing.

A simple fact should be obvious but must be emphasized: the plotter creates no graphs on its own. Understanding this is *essential* to the whole process. The plotter takes the software commands and develops the graph from these commands. Therefore, the graph produced is no better than the software that is used to drive the

At a Glance

Name
Strobe Model 100 Computer Graphics Plotter

Manufacturer
Strobe Inc.
Building 5A
897 Independence Ave.
Mountain View, CA 94043
(415) 969-5130

Type
Drum-type plotter using 8½- by 11-inch (maximum) sheets of paper, transparency sheets, or foil. Plotting area is 8 by 10 inches (20.3 by 25.4 cm)

Use
To create hard-copy graphics from digital data

Price
$785

Dimensions
Height 3½ inches (8.9 cm); width 16¼ inches (41.3 cm); depth 8½ inches (21.6 cm)

Documentation
16-page booklet

Computer Interfaces

TRS-80 Models I and III	$110
Apple II and III	85
S-100 bus	145
Commodore CBM/PET	119
RS-232C Serial	195
Osborne	90

Software

Strobeplot and Busgraph	$145
Difplot	50
Strobeview	75
Screendump	75
Plot Applications Software: Plot1.8; Plotsub; Draw8; Typer	70

(not all software packages are available for every computer interface)

Audience
Personal or business computer users who need to create graphs and charts from digital data

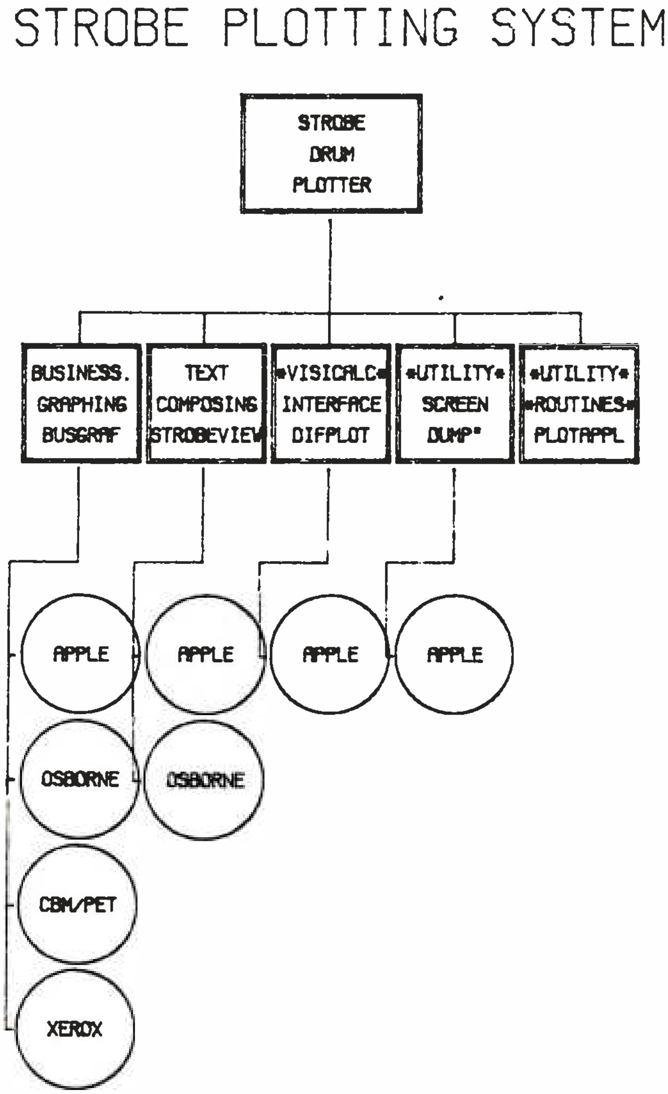

Figure 1: *Strobe Plotting System. The various graphics packages available from Strobe for the plotter and the computer systems on which the packages run are illustrated in this chart created by the author with the Strobeview program.*

Strobe plotter. If the software you choose produces a decent graph (*you* are the judge), then you can count on the Strobe to do its part, with some limitations.

Strobe Software

The Strobe Plotting System consists of five sets of software programs, separately priced, in addition to the plotter hardware (see figure 1). Not all of the software in the set is available for all microcomputers. The Strobe System is keyed to the Apple II and can be run with the Osborne. Other systems may be added.

Busgraf

The Busgraf set of programs is the key to the Strobe software, providing pie charts, as well as bar graphics—but no line graphs, a serious limitation to me. Sometimes a bar graph tells the story well; sometimes a line graph would be better. I need graphing software that does both.

Busgraf is composed of four programs: Bar Graph, Pie Chart, Bar Graph File Editor, and Pie Chart Editor.

When I initially went through the Bar Graph instructions, I followed a demonstration program to familiarize users with the operation of the software. The inclusion of such a program is a great help in understanding the intentions of the program authors and the instructions. However, small problems with the demonstration program, such as the disk catalog appearing one way in the text (two columns, side-by-side) and another way on the screen (one column), make this program unsatisfactory as a guide. In addition to inconsistencies, the screen "hangs up" at (or near) the end of the catalog. Have no fear, though. By pressing the return key, you can overcome the lack of care in the design and implementation of the software.

A second program in the Busgraph package, the Bar Graph File Editor, enables you to edit the titles and labels

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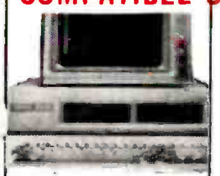

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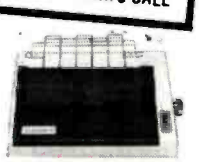

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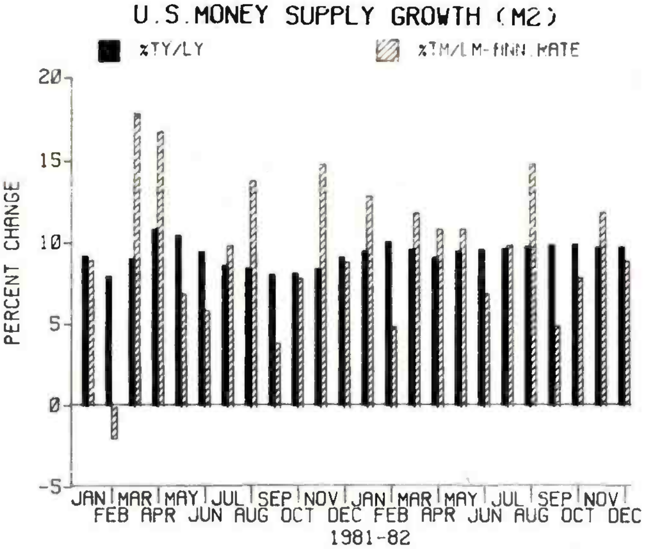

Figure 2: *A side-by-side bar chart using the Busgraph set of programs.*

(Main, x, y, and Legend), change the shading and pens, and vary the data values. The number of bars and subbars and scaling factor for the y-axis, and x-axis label option cannot be changed after the initial selection is made. Make a mistake in editing (like a repeating minus sign), and you may find yourself dumped out of the program into Applesoft.

On the bright side, Busgraf provides an x-axis that can be labeled with weekdays (5, 10, 15, 20), dates (7, 14, 21), or months (3, 6, 12, 18, 24), as well as numbers. Very useful for business graphs, but years and quarters are needed to complete the set and the limits are pretty confining for the work that I do in economic planning.

Note, no opportunity exists to preview a graph on the monitor before plotting begins, a real waste of time and paper.

The graph I used to test the Busgraph package is designed as a line for the year-to-year percent changes and bar for the month-to-month precent changes at an annual rate. Busgraph couldn't duplicate this but instead implemented it as a side-by-side bar chart (see figure 2).

The overall layout of the graph is excellent. Legends are clear and well placed. (Shadow overprinting of titles is possible.) The x-axis labels are a tad jumbled by my eye but better than those on 80 percent of the graphs I have seen produced on microcomputers. Overall, a decent graph is possible with the Busgraph package in spite of all the problems.

The Strobe Plotter can be judged on the basis of the plot in figure 2. Close examination reveals that the y-axis doesn't quite line up with either the 0 line or the x-axis reference line (at −5). Most of the bars do not start at 0 but seem to start at about −0.1 or so. The bars overlap some, and the overlap increases toward the right side of the graph. The third striped bar from the left is miswww.americanradiohistory.com

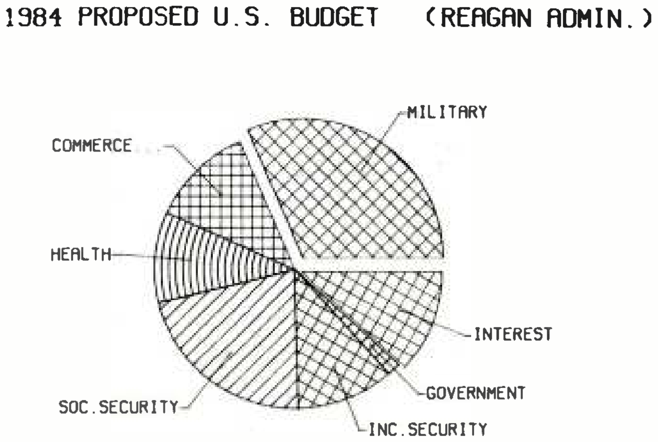

Figure 3: *Pie chart produced with the Pie Chart program of the Busgraph software, which gives you the option of breaking out any section of the pie for emphasis.*

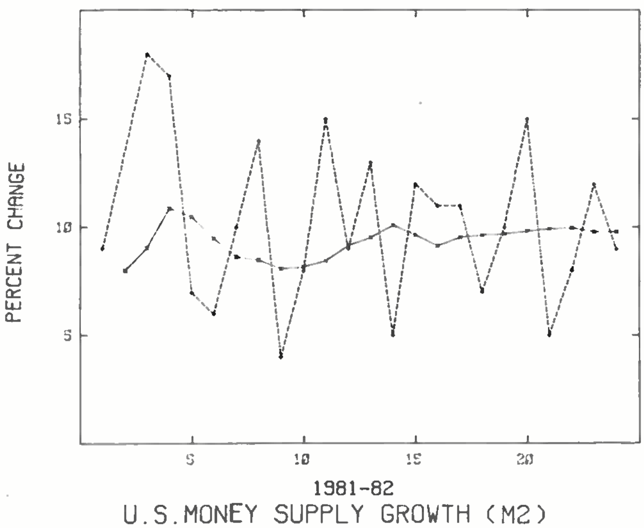

Figure 4: *Line graph drawn using the Strobeplot programs.*

aligned at the top. In short, the plotter produces a graph that is merely adequate.

The problems I had with the bar graphs should have warned me about the pie charts. As I created the chart under the Auto option, all went reasonably well until I entered the main title. At that point, the program indicated that the data was filed and dumped me out in the cold. The disk catalog revealed the filename (without an .xxx filename suffix), so I started the program again and directed the program to the existing file. The program reported the file couldn't be found, and—to maintain a weird sense of consistency—erased the file! My frustration mounted as I went through this process three times before I gave up and tried the Manual option; it worked—sort of. The data entry of my first graph was complete (again no preview on the monitor) up to the point of running it on the Strobe. On my first attempt, all the parts of the pie were made, the first title completed, the second title started, and then the program aborted. I finally succeeded in combining several segments to produce an excellent chart, with the option of varying colors and shading (see figure 3). The capability to break out any or all segments and specify how much separation for each is a very good feature and seldom seen even on large systems.

[**Editor's note:** *The Strobe software has recently been upgraded from the version reviewed here. One of the changes enables the various programs to interchange data so that the user can create different types of graphs using the same data. . . .* **S. J. W.**]

The Strobe Plotter's performance generally was excellent. The registration (ability of the machine to keep within the lines) was somewhat uneven but not significantly. Several letters were "nervous"—not smoothly executed (e.g., in figure 3, S, C, U). My opinion is that Busgraf is better than a dot-matrix screen dump but not suited for high-quality graphs.

Strobeplot

To produce line charts, the Strobe System provides a second set of software, Strobeplot. The data goes in one file. The commands to turn the data into a graph go into a second (option) file. The chance to add grid lines with the option file caught my attention, but the program editor always skipped over that choice. The rest of the option file structure worked as advertised. On execution, the program asked me to put the data and option files in D1 (drive 1). After a few abortive attempts, I realized that D1 to this program meant the current drive (which was D2 the way my disk drive was set up, as the fates would have it).

The plotting, even without the ability to preview the results of my commands on the screen of the monitor, worked without incident. The pen stayed down at the end of the axis-drawing portion of the process, causing some small additional lines when the pen was switched to change colors. To overcome the problems of loose paper, I smoothed the graph down to provide a better-quality product (see figure 4). The Busgraf programs (and most other plotting programs I have seen) put the title at the top of the graph; Strobeplot doesn't. The quality of the plot was fine, but after three attempts, I stopped trying to get the data squared away as the negative number I was trying to plot was dropped, without even a warning.

Screendump

This is a hardworking program with no frills (such as the capability of scaling or rotating the image). The screen image is transferred to the paper one dot at a time. All the movement of the pen on the paper loosened the paper and produced, in spite of my attempts to hold the paper down, a less than satisfactory graph. With the wide spacing between the dots, I couldn't conceive of using the resulting graph at full size. In fact, I can't think of any way this process is preferable to a screen dump to my Epson. The plotting process with the Strobe software takes approximately half an hour (compared to a minute for my Epson), and the graph would need to be reduced to bring the points together before I would use the product.

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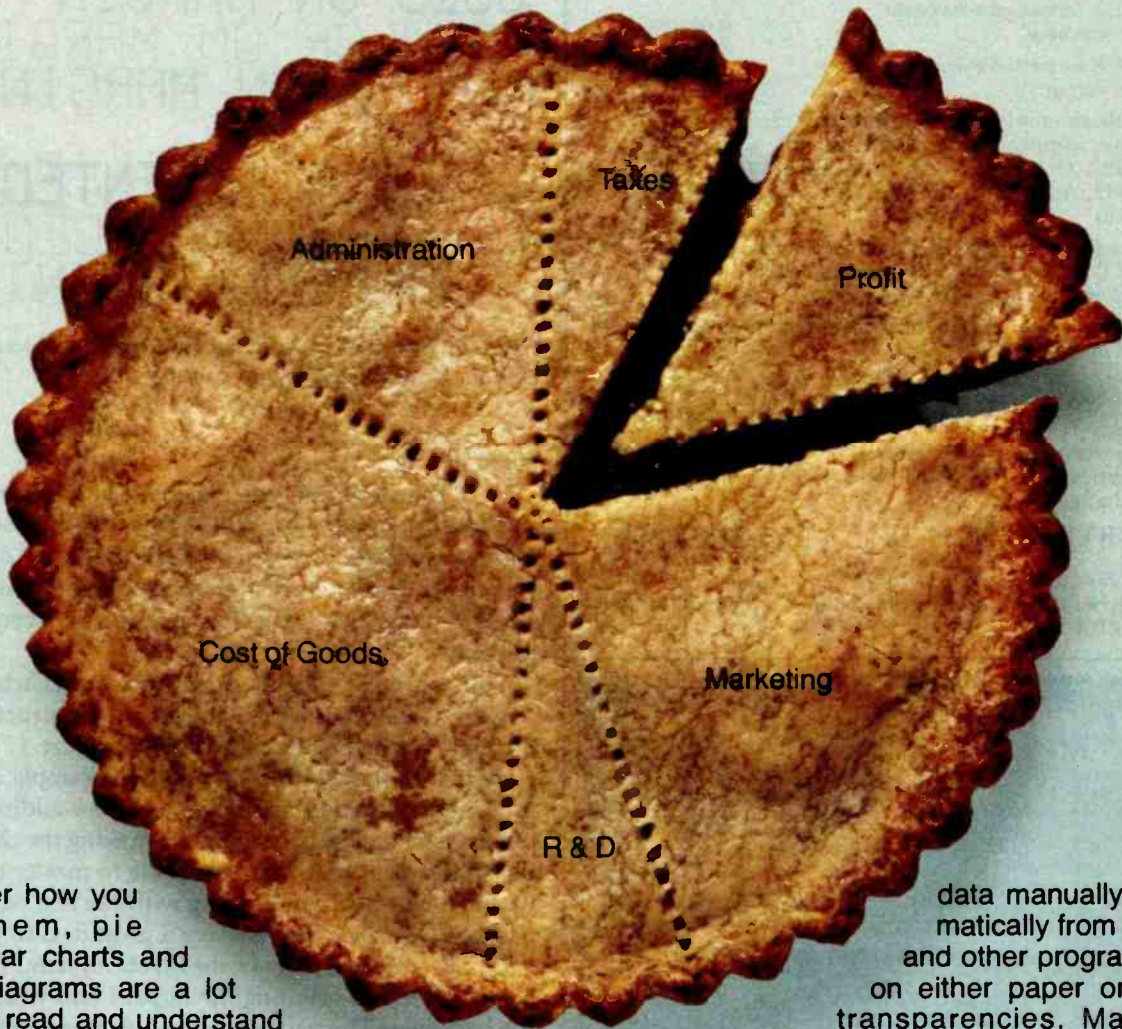

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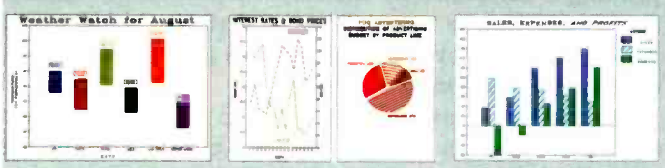

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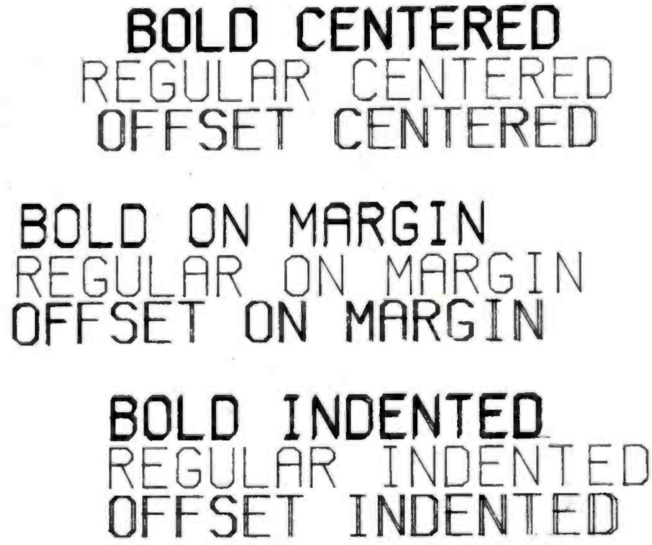

Figure 5: *Examples of different type styles and sizes available with the Strobeview program.*

Strobeview

With this program, you can make large slides for overhead transparency projectors. You can also use it to type large-size words in either regular, bold, or offset fonts (see figure 5). Strobeview permits a large variety of type sizes. Setting type at either margin and centering are possible.

You can create simple organizational charts with this powerful utility. I used it in setting the structure of the Strobe Plotting System illustrated in figure 1. Charts are restricted to the width shown in this example and can be longer by one additional level (e.g., an additional computer system). The procedure for making the chart is a little confusing at first, but I was able to master the process within a half hour. In keeping with the rest of the Strobe package, the instructions leave a great deal to be desired.

Of the software parts of the Strobe system, Strobeview comes closest to fulfilling the hopes I had when I opened the packages. The package would be more useful if it had the capability to autoscale each line (allowing manual overrides of course) and preview graphs on the screen. Because automatic scaling is not available, plotting off the edge of the page is very easy, resulting in a damaged pen point and shredded paper. The start position for printing is controlled by the cursor control keys, labeled as arrows, on the top right side of the machine. As it exists now, Strobeview is adequate as a simple first-generation text-plotting package.

Another program available from Strobe but not evaluated here is Difplot, which plots Visicalc (or presumably other) data saved in the DIF format.

Plot Applications Software Package

For those whose needs aren't supplied by the software reviewed so far, the Strobe folks have a Plot Applications Software Package that gives you greater control over the functions of the plotter. The package includes:

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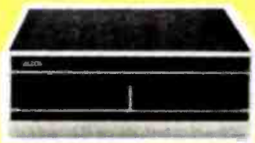

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•Plot1.8: a machine-language driver to allow your software to control the drum and the pen to make a written copy of your plot. Variable names and hexadecimal/decimal addresses are provided in the instruction manual for plotting a vector, drawing an alphanumeric character, controlling pen motion with switches, and initializing variables and the input/output port.

•Plotsub: this subroutine provides entry points for the vector (x and y coordinates), a switch for the position of the pen, and input for the string of alphanumeric characters to be plotted (including their position on the paper and whether to go up or down, or left or right).

•Draw8: this subroutine plots a series of curves in a common format. Again, no previewing is included in the routine. Care must be taken to prevent parts of the graph from printing on top of other parts. The first time through the program, you need to use a instruction card (or "cheat sheet") so that you have the proper responses ready in the right order. If the title is too long to fit on the page, the plotting continues on the drum of the plotter off the edge of the paper. Without the ability to pause for change of pens, single-color graphs are the only choice. The title is set up at the bottom of the page as in Strobeplot, discussed previously. Data points are not saved by the routine, and legends are not available to identify the lines of the graph. Nothing to write home about here, but possibly something to build on.

•Typer: this utility plots strings of characters entered from the keyboard. The strings will be plotted either horizontally or vertically and may go off the page depending on the size of the type that is specified. I think less than 10 lines of code could be added to cause a warning to be printed, suggest alternative type size, and give you the opportunity to put fewer words on the line. Surely, this kind of change will be available before long.

Conclusion

My evaluation of the Strobe System is based on a comparison with the Tektronics system I have used for five years and several Hewlett-Packard plotters, all of which cost more (the Tektronics a great deal more) but produce better-quality graphs than Strobe Plotter. Without a doubt, at $785 the Strobe is an adequate plotter for the money, but it falls short of my expectations.

The Strobe software is an embarrassment and should be thrown out or redone. The basis for a decent plotting package could be built on the frame of the incomplete, poorly documented, and disjointed packages that are provided, but I wouldn't try.

I used other software packages (Apple Business Graphics and Graftalk) to drive the Strobe plotter to provide a fair test of the machine. Using another company's software proved to be a substantial advantage (see figures 6 and 7). I judged the quality of these graphs to be more than satisfactory. The registration is fine. The letters are sharp, lines clear, and a very good plot is developed. The plots made with non-Strobe software and with the Strobe plotter are better than those I am used to from an Epson.

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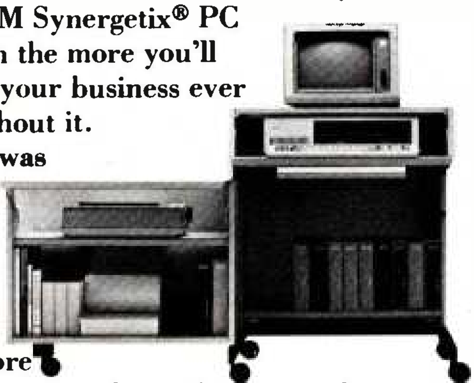

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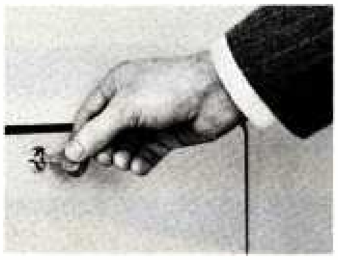

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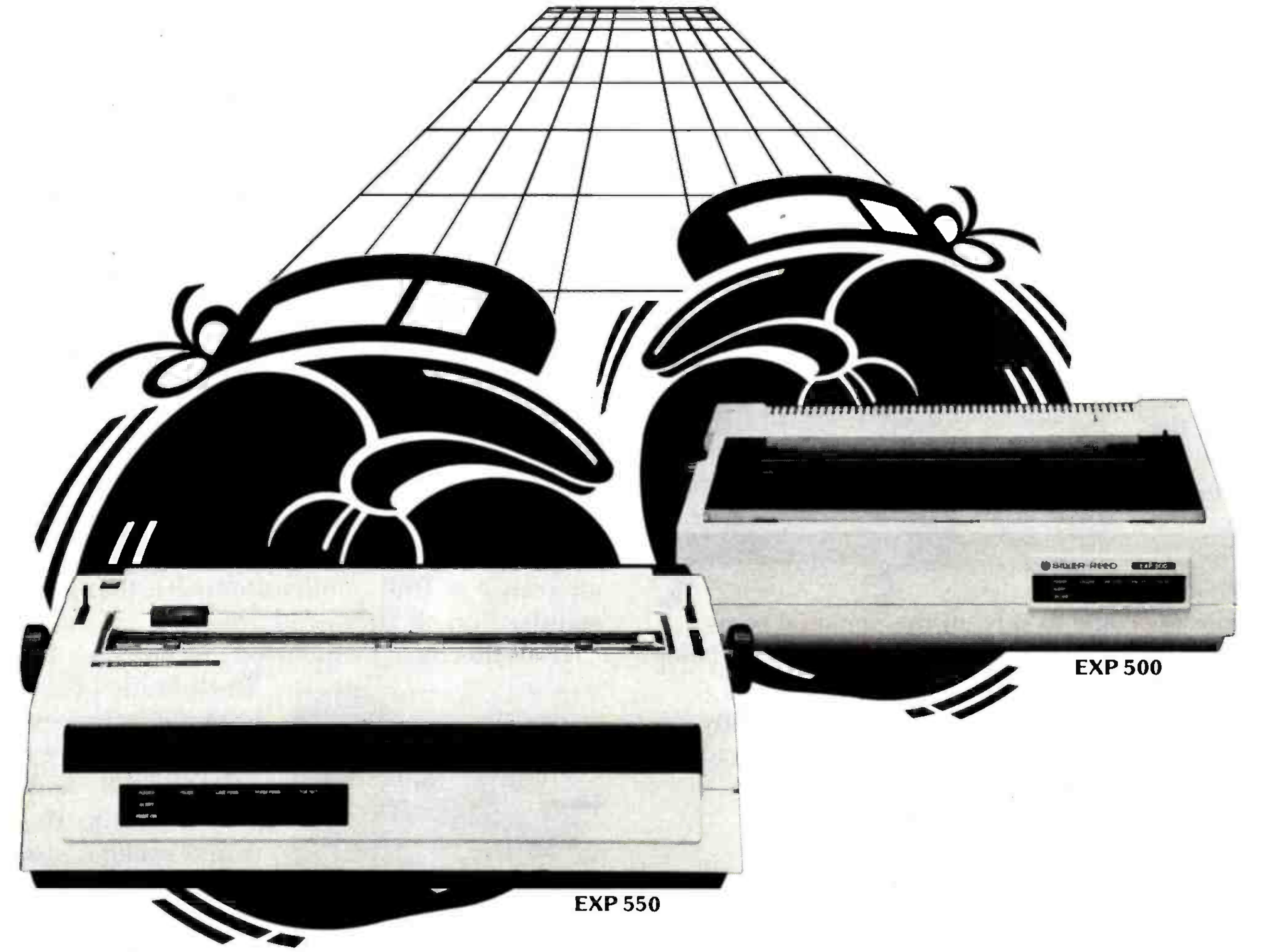

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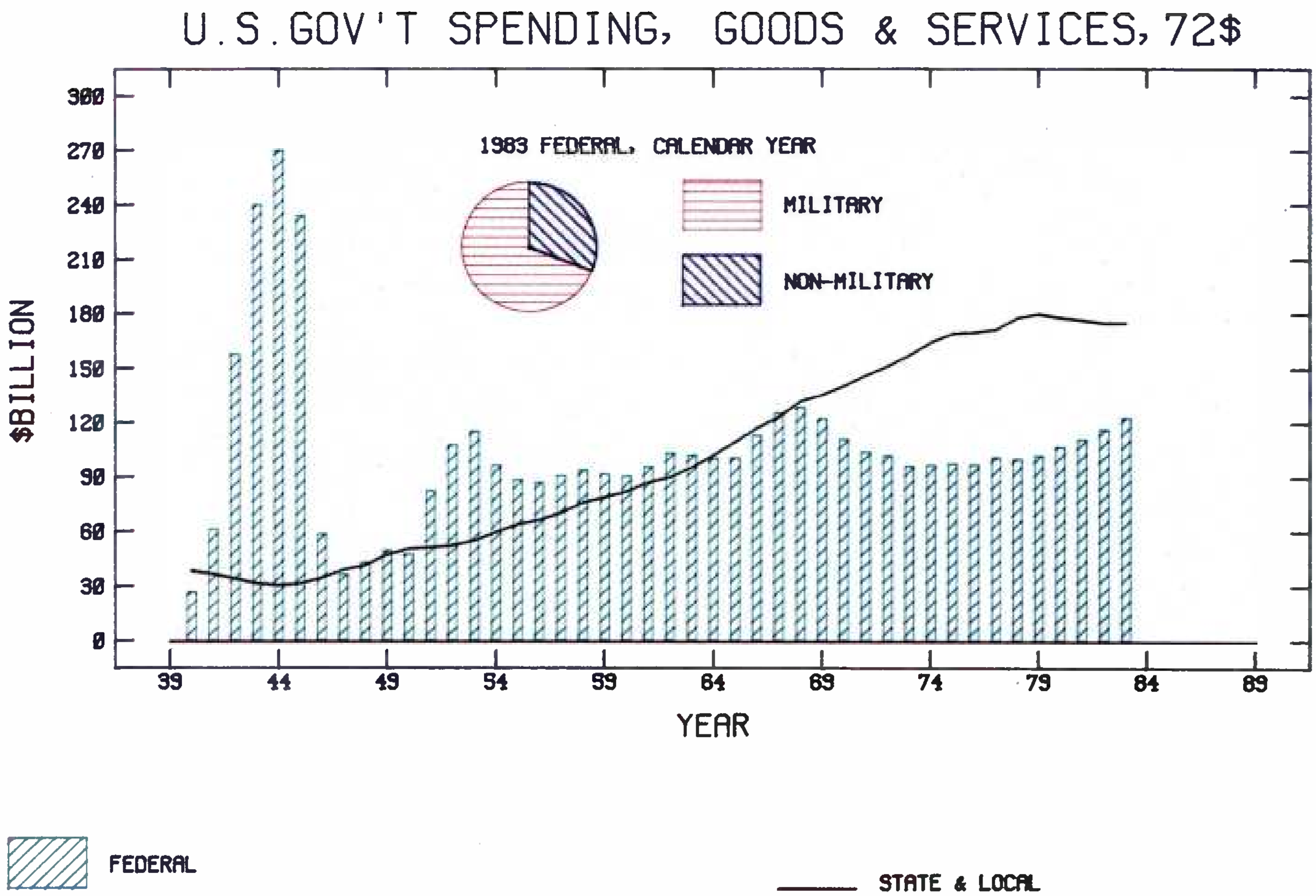


Figure 6: *Combination bar, line, and pie chart drawn with the Strobe Plotter driven by the Apple Graftalk program running on the Sony MBC-1000 computer. Multiple colors are achieved by stopping the program to change to different pens.*

I think you will find the Strobe's strongest point is its price. Before the first month of your ownership of the Strobe ends, you should find some way to hold the paper down adequately. (Probably you will keep a screwdriver nearby to tighten and loosen the five small screws in the hold-down bar for plotting each graph.) You may also find the slow speed of the Strobe not objectionable. Pen changing is time-consuming, and you will probably find one-color plots are preferable after a while.

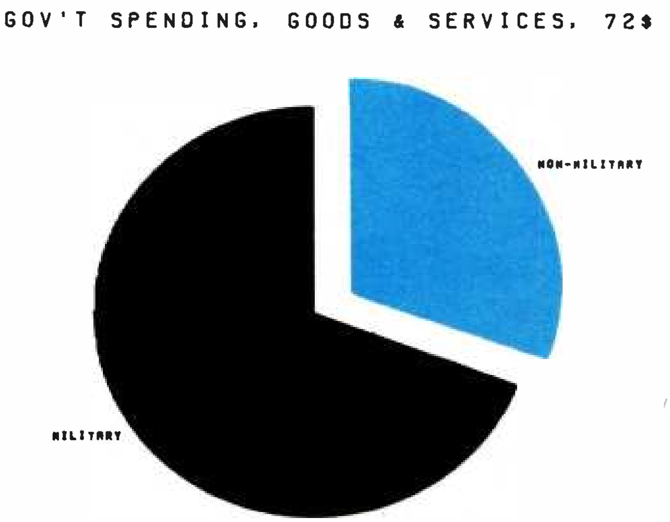


Figure 7: *A pie chart drawn with the Strobe Plotter driven by the Apple Business Graphics program.*

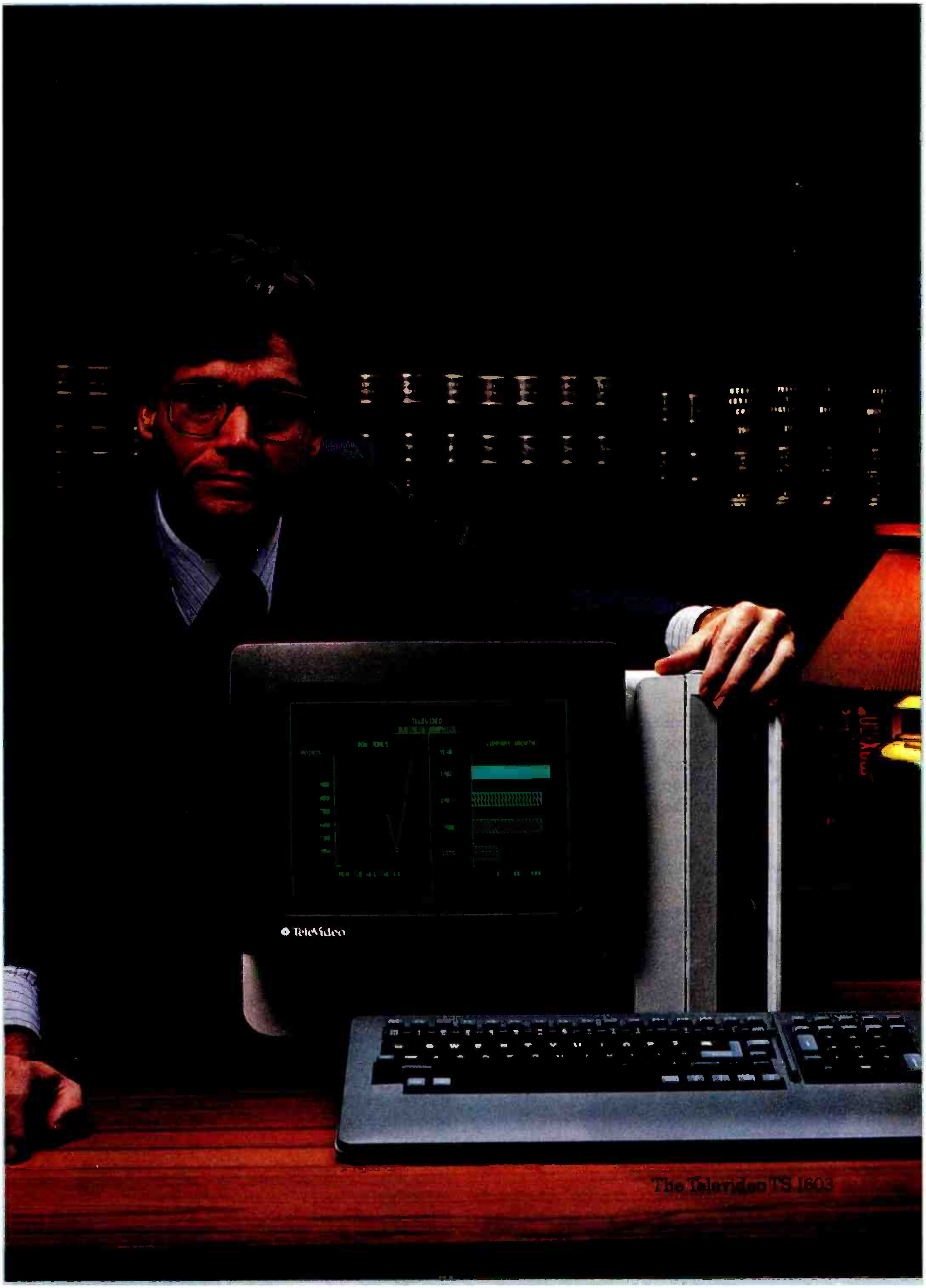
When I first saw the advertisements, I yearned to hook the Strobe up to my computer. My expectations have decreased after living with the Strobe for several months. The plotter's usefulness depends on whether independent software houses include drives for it with their products.

The plotter is part of a plotting system; don't select the plotter (Strobe or any other) without selecting the software at the same time. Both plotter and software must be purchased together to avoid great disappointments on the way to an acceptable graph.

The Strobe certainly is a decent product. Whether it is worth the money for you will require a close look on your part. I cannot provide an overall "buy" recommendation, but you will find the Strobe an inexpensive alternative—and a long step forward from the dot-matrix screen dumps you may have used up to now.■

About the Author

Jack Bishop (Bishop Associates, 916 Maple Ave., Evanston, IL 60202) is a management consultant specializing in planning and economic issues. His article "Beyond the Peaks of Visicalc" appeared in BYTE in October 1982.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The Touch of Color

An inexpensive way to add a high-quality keyboard to the Color Computer

by David M. Dacus

Radio Shack's Color Computer has many things going for it, and low cost is chief among them. But when companies set out to build inexpensive computers, the keyboard is usually the first place they cut costs. I decided to give my Color Computer a new lease on life with an improved, detached keyboard. With a minimal investment ($30), I constructed the keyboard (see photo 1) and installed it without any permanent modifications to my computer.

Photo 1: *Keyboard in completed case. The 16-conductor ribbon cable, extending out the back, has a connector that allows plug-in replacements.*

The Problems

When we got our Color Computer way back in the winter of '80, the whole family was impressed with all its features and capabilities. As time passed, however, we became aware of a glaring imperfection—the keyboard. We were accustomed to the touch of an Olympia 77 typewriter, and the features of the keyboards of Wang, UNIVAC, and VAX equipment. The feel and layout of the Color Computer were inferior.

I discovered other problems when I began developing a word-processing program for the Color Computer. There weren't enough keys to provide control commands without limiting text entry. In addition, we really needed a numeric keypad.

My search for a solution to these keyboard problems was complicated by my philosophy: I refuse to add costly items to the Color Computer because its inexpensive price was my main reason for buying it.

No one writing in BYTE or any of the other computer magazines I read regularly was offering to solve my problems for me. In spite of my inexperience with hardware construction, I decided to do it myself.

Feasibility

The Radio Shack technical manual for the Color Computer provides the wiring diagram for the simple switch-matrix keyboard. I found that the only function the keyboard performs is the closing of the appropriate circuit. The pulse this produces is taken care of by the computer's printed-circuit (PC) board. The task of constructing a replacement keyboard seemed manageable.

I noticed that there were four slots on the keyboard matrix not being used by the Color Computer (see figure 1). If these unused circuits could be decoded as ASCII (American National Standard Code for Information Interchange) characters by the computer, perhaps I could use them.

Through experimentation, I found that the unused circuit combinations

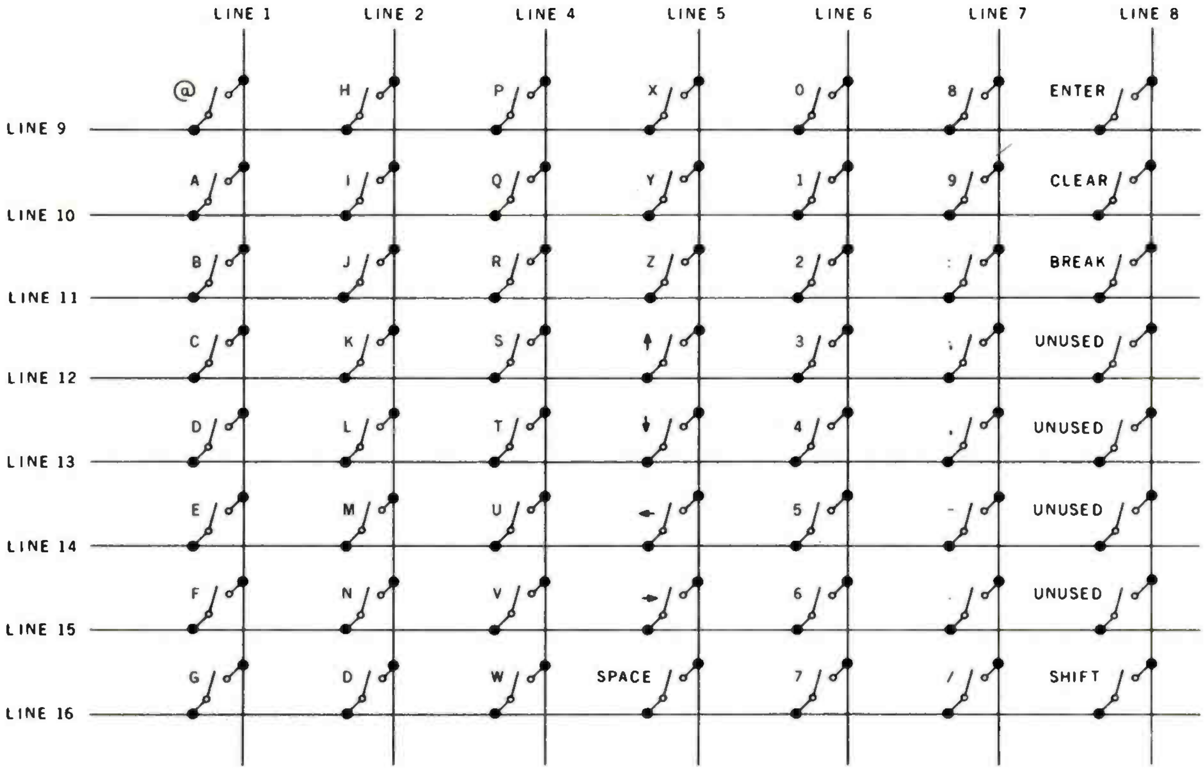

Figure 1: *Matrix of key switches found in the Color Computer's keyboard. To detect a key closure, the computer sends a pulse on each line along one axis, while scanning the lines along the other axis. If a key is closed, the pulse will appear on some second-axis line. Line 3 has no connection.*

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do indeed work as follows:

- Lead 8 connected to lead 12 sends an @ (ASCII code 64) and nothing while the shift key is pressed.
- Lead 8 connected to lead 13 sends a graphic symbol (ASCII code 189) and an SOH (start of header, ASCII code 1) when shifted.
- Lead 8 connected to lead 14 sends g (ASCII code 103) whether shifted or not.
- Lead 8 connected to lead 15 sends EOT (end of text, ASCII code 4) and a graphics character when shifted.

The circuits 8 connected to 12 and 8 connected to 14 were not unique on the keyboard and so could not be used for control of word processing: but 8 connected to 13 and 8 connected to 15 were exactly what I needed.

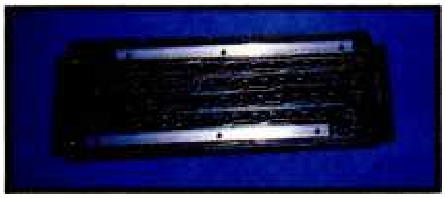
I obtained a Key Tronic 66-key keyboard from Poly Paks of Wakefield, Massachusetts (see photo 2) and ran a test to determine if I could use the existing printed circuits. The keyboard has a 20-lead matrix that appears to be set up for a dedicated word processor. I was able to use a few of the leads on the board, but most had to be cut.

The key contacts are easily accessible from the bottom of the circuit board. The contacts are two wires soldered to traces on the circuit board (see photo 2b). This arrangement provides a simple means of connecting the key to the appropriate leads of the wiring matrix. I suggest the following procedure for construction of the new Color Computer keyboard.

Circuit Board Preparation

Determine from the keyboard matrix (see figure 1) which keys must be connected to which leads. Use the following protocol: Connect the vertical leads (lines 1 through 8, except line 3, which is used only as a ground on the main circuit board) to the top lead of appropriate keys, and the horizontal leads (lines 9 through 16) to the bottom lead of the appropriate keys. Select nonalphanumeric keys to connect to leads 8 connected to 12 through 8 connected to 15.

(2a)



(2b)

Photo 2a and b: *Two sides of the Key Tronic replacement keyboard.*

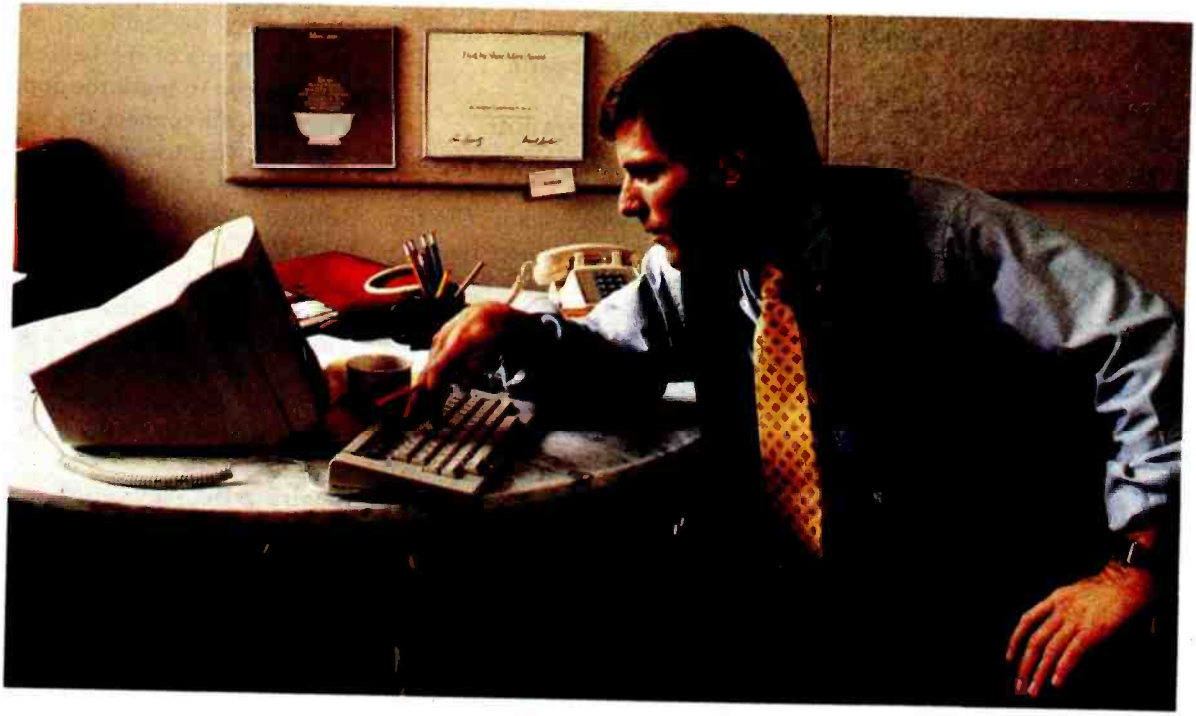
Once you determine which keys to interconnect (see table 1), study the printed circuits of the keyboard. Use a felt-tip pen to mark the appropriate PCs that will connect the keys. You must remove the keys to reach the circuits printed on the top of the board. Remove and replace the keys with a small Phillips screwdriver.

After marking all of the circuits you need, use a high-speed grinder with a round burr to cut all unwanted traces. Carefully remove all debris from the board to prevent short circuits; then reinstall the keys.

Rewiring the Keyboard

Use a 30-watt pencil-type soldering iron and 30 AWG insulated wire-wrap wire to connect each lead to the keys as indicated in table 1. Solder quickly to avoid loosening key switches or melting insulation. Make your connections as direct as possible without bridging unconnected solder points.

Cut a wire-wrap female header so that you have a 16-pin single-inline connector. Then use a wire-wrap tool to attach wire to pins 1, 2, and 4 through 16. Solder these if you want extra security. If you hold the header with the wire-wrap pins pointing at you, the pins are numbered from left to right. Solder each numbered wire



THE PERSONAL COMPUTERS DESIGNED FOR PEOPLE WHO DON'T KNOW HOW TO USE ONE.

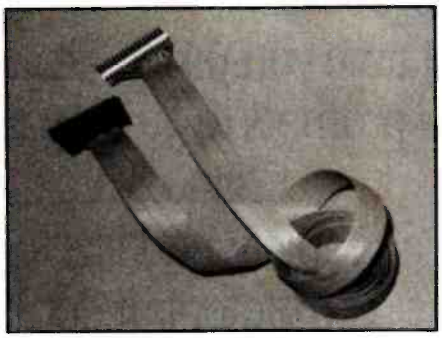
Line	Connect to top lead wire of the following keys:							
1	@	A	B	C	D	E	F	G
2	H	I	J	K	L	M	N	O
3	no connection							
4	P	Q	R	S	T	U	V	W
5	X	Y	Z	↑	↓	←	→	Space
6	0	1	2	3	4	5	6	7
7	8	9	:	;	,	—	.	/
8	Enter	Clear	Break	F1	F2	F3	F4	Shift

Line	Connect to bottom lead wire of the following keys:						
9	@	H	P	X	0	8	Enter
10	A	I	Q	Y	1	9	Clear
11	B	J	R	Z	2	:	Break
12	C	K	S	↑	3	;	F1
13	D	L	T	↓	4	,	F2
14	E	M	U	←	5	—	F3
15	F	N	V	→	6	.	F4
16	G	O	W	Space	7	/	Shift

Table 1: *Key connections. By modifying the keyboard so that it matches these specifications, the Color Computer can access the keys just as it does its standard keyboard.*

(3a)

(3b)



(3c)

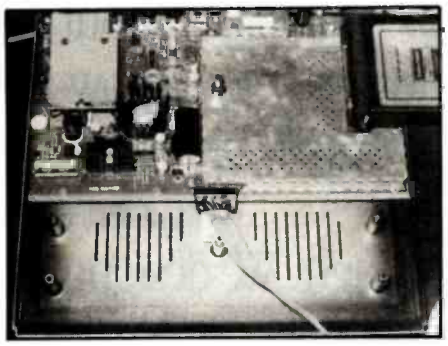


Photo 3a, b, and c: *Major components required for installing the replacement keyboard. Photo 3a shows the modified Key Tronic keyboard with its 16-pin connector that mates with the ribbon cable in photo 3b. The other end of the cable is connected in place of the Color Computer's standard keyboard as shown in photo 3c.*

to the key closest to the top of the board in the appropriately numbered line (see photo 3).

Constructing the Cable

Connect a 16-pin male header to one end of a 16-conductor ribbon cable, and a 16-pin female connector to the other end. The numbering scheme for the header connectors and ribbon cable must be identical to that used for the header connector attached to the keyboard (see photo 3b). Do not connect conductor number 3 on either end.

If you have difficulty locating 16-conductor ribbon cable, you can split either 20- or 40-conductor cable if necessary (Radio Shack sells both). I used a 5-foot length because that is the length Radio Shack sells and because with that length I can place my computer at the rear of my table, freeing plenty of space around my workstation.

Checking for Errors

Use an ohmmeter with small probes to check all circuits. Refer to figure 1 for the appropriate leads for each character. If you connect the probes to the appropriate leads for a

Text continued on page 279

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Summer Specials

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Applied Software Technology		
QBASE	189	143
Versaform	389	259
Aptek		
Epson to Prism		38
PC Ticker Tape		22
Rainbow Writer		125
Ashton-Tate		
dBASE II [5]	700	398
dBASE II w/User's Guide [5]	729	449
Financial Planner	700	489
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Proofreader 50K	50	38
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BSTMS	200	149
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Condor 1	295	189
Condor 3	650	398
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Eagle		
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Smartcom 2	119	90
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Tax Preparer 1983	250	185
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Mathemagic	90	65
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Volkswriter	195	129
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Mince	175	139
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Benchmark Word processor	500	367
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Tax Manager	250	188
Micro Pro		
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Mailmerge	250	165
Reportstar	350	231
Spellstar	250	165
Word/Mail [4]	695	426
Word/Spell [4]	695	426
Word/Spell/Mail [4]	845	558
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Legal Billing/Timekeeping	750	385
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Flight Simulator	50	38
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Combined Enhanced Graphics	55	40
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Comshare		
Image Maker	175	126
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DBCalc		20
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Graphmagic	90	65
Mathemagic	90	65
Kensington		
Format II	150	113
Lightning		
Master Type	40	30
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Data Fax	199	149
Data Link	100	75
Link Disk	70	51
Link Index	195	149
Link Sampler I	60	45
Link Video	55	42
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Data Perfect	100	78
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Data Factory	300	216
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Painter Power	40	30
Payroll Manager	300	216
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Visiblend	50	37
Visifactory	75	54
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Multiplan	275	198
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Supertext Professional	99	74
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PBL		
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Sensible Speller Pascal	125	94
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Screenwriter Professional	200	149
Silicon Valley		
Dictionary	125	94
List Handler	90	68
Word Handler	199	145
Sirius		
Pascal Graphics Editor	100	75
SOF/SYS		
Executive Secretary	250	188
Executive Speller	75	56
Softech		
BASIC Compiler & Runtime [5]	225	169
Softech	125	94
UCSD p-System Set	625	469
Xenofile	50	39
Software Dimensions		
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AP	395	289
• AR	395	289
• GL	395	289
• Inventory	395	289
• Payroll	395	289
• POE	395	289
• POS	395	289
• SOE	395	289
Software Publishers		
PFS: File	125	94
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Data Capture/ Superterm	90	65
Southwestern		
ASCII Express Professionl	130	89
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Printographer	50	38
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Compucube	30	23
DBMaster	229	148
DBMaster/Hard Disk	499	359
Electronic Price Sheet	100	75
Graphics Proc Sys (Prof)	179	129
Graphics Proc. Sys (Std)	69	52
Micro Memo		
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Utility Pak 1	99	65
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Mailing List Database	50	38
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80 Col Preboot Visicalc	49	37
Videoterm Utilities Disk	37	28
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Visidex	250	194
Visifile	250	169
Visilink	250	194
Visiplot	200	156
Visischedule	300	234
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Winner's Circle		
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APPLE IIe SOFTWARE

Most Apple II products also run on the IIe (call for details). Products below are specially designed for the IIe.

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• AR	395	289
• GL	395	289
• Inventory	395	289
• Payroll	395	289
• POE	395	289
• POS	395	289
• SOE	395	289
Software Publishers		
PFS: File	125	94
PFS: Graph	125	94
PFS: Report	125	94
Visicorp		
Visicalc	250	189

APPLE /// SOFTWARE

Applied Software Technology	LIST	SALE
Versaform	495	371
Datamost		
Write On	130	99
Denver Software		
EASY	750	562
Insoft		
ALD System III	75	56
Transforth III	125	94
Link Systems		
Data Fax	249	187
Link Index	195	149
Link Sampler I	60	45
Link Video	55	42
Software Publishers		
PFS: File	175	129
PFS: Graph	175	129
PFS: Report	125	94
Visicorp		
Business Forecasting Model	100	78
Desktop Plan	300	234
Visicalc Advanced	400	312
Visischedule	300	234

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Wildcard	130	109
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Micromodem II [5]	379	259
Kensington		
System Saver Fan	90	69
Kraft		
Joystick	65	49
LJK		
Lower Case Char Gen	25	19
Micro-SCI		
A2 35T Disk Drive	479	329
Microsoft		
16K Ram Card	100	69
Premium System [5]	695	489
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Anderson-Bell		
ABSTAT		359
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Medical (PAS-3)	995	749
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Bottom Line Strategist	400	279
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dBASE II w/User's Guide	729	419
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Grammatik	75	56
Proofreader	50	38
Balcones		
BOSS Fin. Acctg System	2495	1496
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BSTMS	200	149
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Cardbox	245	177
Comm soft		
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FABS-BTree File Access	195	146
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Target Application Guide	50	38
Combo Pak	125	94
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Palantir	425	319
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Random House Thesaurus	150	113
Digital Research		
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FMS 80-2	495	312
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Microstat	295	248
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Supervyz	150	94
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Micro B+ (Other)	260	211
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dUTIL	99	59
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dBPlus	125	95
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Spellbinder	495	281
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Spellstar	250	165
Supersort	250	165
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Circle 336 on inquiry card.

particular key and then depress that key, the meter deflection should indicate a completed circuit.

If the circuit is complete, you next check for shorts by depressing all other keys one at a time. Any movement of the needle indicates a short in the circuit. If this occurs, make sure you cut all unneeded PCs. Also look for melted insulation between two overlapping wires. Make any necessary corrections before moving on.

After you are satisfied that the circuits are correct, plug the cable into the keyboard connector and repeat all the tests. This double-checks your work on the keyboard and assures you that you built the connector cable correctly as well.

Take a deep breath and exhale. It's time for the *real* test with the computer. Unplug everything and place a bath towel or other suitable padding on your work surface to prevent scratching the case. Be sure that you are not carrying a static charge. You aren't going to touch anything critical, but it pays to be careful.

Turn your computer over and unscrew the seven screws in the case with a Phillips screwdriver. (This voids your warranty if you still have one.) Turn the computer over, being careful to catch the seven screws, and put them in a safe place until reassembly time. Lift off the top of the case and set it aside. Lift the keyboard off the four posts on which it rests, and locate the short 16-conductor cable attached to 16 pins on the computer circuit board. Gently slide the female connector off the pins on the circuit board and set the keyboard aside.

The pins on the new keyboard are numbered 1 to 16 from left to right as you face them. Gently slide the female connector of your new ribbon cable over the pins on the circuit board (photo 3c) and set the case top loosely back in place on the computer.

Make certain that connectors 1 through 16 of your cable match pins 1 through 16 of the computer. Check your entire work area for shorts and hazards such as stray screwdrivers lying in the wrong place. When you are sure that you have removed all

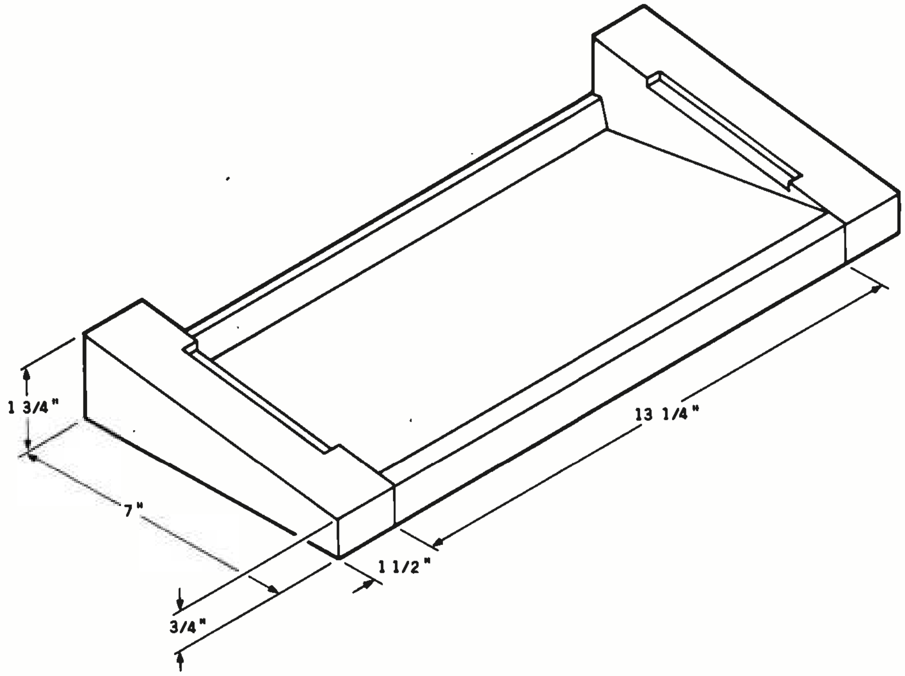


Figure 2: *Keyboard case frame. Dimensions for the various pieces are provided in inches. Most pieces can probably be cut from scrap lumber.*

hazards, cross your fingers, plug the computer in, and turn it on.

If the wrong letter appears when you press a key, or if two or more letters appear for one keystroke, you have a short or have missed cutting a trace on the printed circuit. The following program will assist you in your debugging efforts:

```
1 A$ = INKEY$ : IF A$ = " " THEN 1
2 A = ASC(A$) : PRINT A,A$ : GOTO 1
```

This program shows you what code a particular key transmits even if the key does not normally print a character to the screen (such as the down arrow). You will be able to tell if a key that does not produce a character on the screen is actually transmitting a wrong character or sending nothing at all.

When you complete your checkout, leave the cable in place, reinstall the old keyboard (to keep out dust and dirt), and put the case back together, allowing the ribbon cable to protrude through the case seam on the side next to the expansion port. Remember that the two short screws fit in the keyboard end of the case.

Building the Keyboard Case

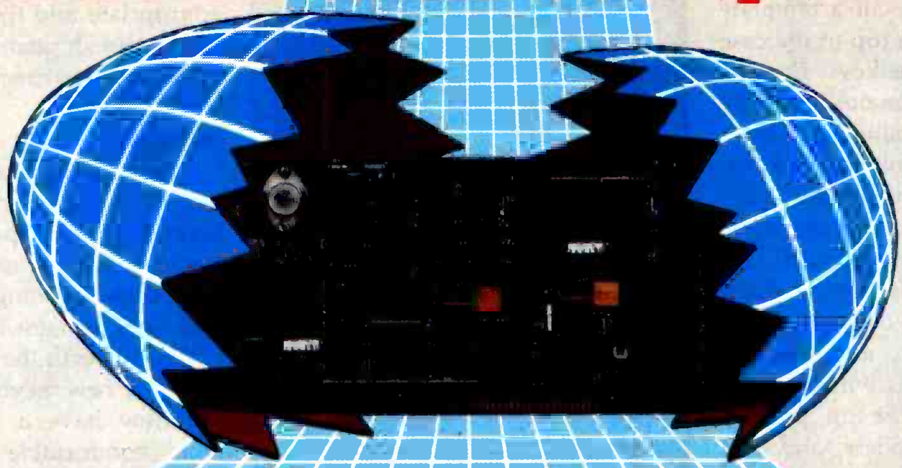
Now that the keyboard is functional, you need a case to keep out dust, coffee, and stray fingers. This part of the project costs little or nothing if you have a few woodworking scraps around the house. (I found all the materials for my case in my woodworking scrap bin and workbench.)

Cut two wedges of 2 by 4 scrap 7 inches long, ¾ inch thick at one end, and 1¾ inches thick at the other (see figure 2). The width of the wedges is the short dimension of the 2 by 4. These wedges form the left and right frame of the case and provide the anchor points for the keyboard.

Cut two pieces of 1- by 1-inch board 13¼ inches long. These are the stringers between the two wedges. Attach the wedges to the stringers at the front and rear with 2½-inch, number 10, flathead wood screws and wood glue (see photo 4). Countersink the screw heads so that they can be covered by paneling. Use a chisel or router to countersink the keyboard-mounting brackets flush with the sloped faces of the two wedges (photo 4b).

Attach paneling to the bottom and

Incubation Complete



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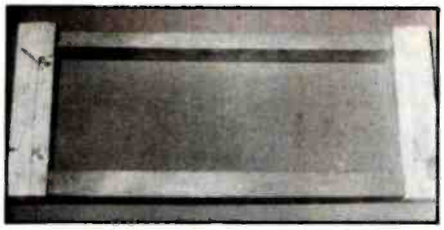
four sides of the case with paneling nails and glue. Next, cut a template out of paper to fit the top of the case and to just fit over the keys. Use this template to transfer the outline of the keys to a piece of paneling. Use a saber saw to cut the hole for the keys.

Drive 1-inch finishing nails partway into the locations for the hold-down screws for the keyboard. Cut the heads off the nails leaving sharp points. Fit the cover over the keys, position it correctly, and tap the paneling over the nails with a mallet or hammer. Remove the top, pull the nails with a pair of pliers, and drill the holes for screws.

Cut a hole in the back panel for cable access and mount the female plug of the keyboard to the stringer with double-stick foam tape. Attach the keyboard cover. Turn the keyboard over and attach four rubber skids to the bottom of the case.



(4a)

(4b)

Photo 4a and b: *Final stages of construction. The frame for the case in photo 4a is made from scrap lumber, then the keyboard in photo 4b is mounted within; later, paneling may be added for appearance's sake.*

Changing the Key Faces

The final step is to give some of the keys a face-lift. For this you will need bottles of black, gray, and white model-airplane high-gloss enamel; medium and very fine artists brushes; and steady hands. Simply obliterate all the incorrect characters on the keyboard with black or gray paint as appropriate and then use a very fine tipped brush and white enamel to paint on the correct characters.

Summary

My total construction time, nights and weekends, amounted to six or seven days. It is probably a one- or two-day job for people who know what they are doing and can sit down and work straight through.

Was it worth the time and effort to install a new keyboard? Definitely. We now have a keyboard with a more comfortable touch for word processing, as well as three additional keys with five usable control characters. Plus, we enjoy the advantages of a numeric keypad when we enter data in our check register and statistical programs. ■

About the Author

David M. Dacus, (1670 Valencia, Las Cruces, NM 88001) is an operations research analyst for the U.S. Army Training and Doctrine Command Systems Analysis Activity (TRASANA) at White Sands Missile Range, New Mexico.

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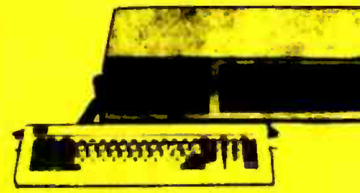

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Improving the User Interface at Digital Research

by Phil Lemmons and Barbara Robertson

"We were very open about it for a while," Gordon Eubanks says, speaking about an iconic user-interface project that is now top secret at Digital Research Inc. "In fact, one version of the interface was shown on a national television program in 1982—fortunately, no one seems to have watched it." But opening its research and development project to visitors did cause Digital Research some confusion. Different visitors at different times saw different versions of an evolving project. Those visitors, OEMs (original equipment manufacturers) and others, went away with different expectations of the project. And once conflicting accounts started to circulate, confusion developed about the real nature of the project. Digital Research finally decided to cloak the project in the darkest secrecy until the time came to announce a product. Even the code name of the project is under wraps today.

Recently a different and perhaps more serious kind of confusion has become apparent: the mistaken view that Digital Research is not making efforts to improve user interfaces for software products because the company fails to see the need. BYTE West Coast Editors Phil Lemmons and Barbara Robertson visited Digital Research headquarters in Pacific Grove, California, to meet with Eubanks, vice-president of the company's Commercial Systems Division. What follows is Eubanks's discussion of the work DRI is doing on user interfaces.

Gordon Eubanks of Digital Research Inc.

Digital Research's efforts to improve the user interface in software involve three broad areas. First, historically, there's the "A>" approach, the programmer's interface. Programmers don't really have much trouble with that. When CP/M was developed, minicomputer operators and programmers were the predominant users of computers. To the people writing software, that A> interface was totally familiar, so it was natural that when CP/M and other systems were developed, that interface was used.

If we'd done something like Apple's Lisa then, people not only would have thought it was strange but probably wouldn't have liked it. It's more verbose, in a sense, and it would have slowed programmers down.

We will not totally abandon the programmer's interface. We will con-

About the Authors

Phil Lemmons and Barbara Robertson can be reached at BYTE/McGraw-Hill, 4th Floor, 425 Battery St., San Francisco, CA 94111.

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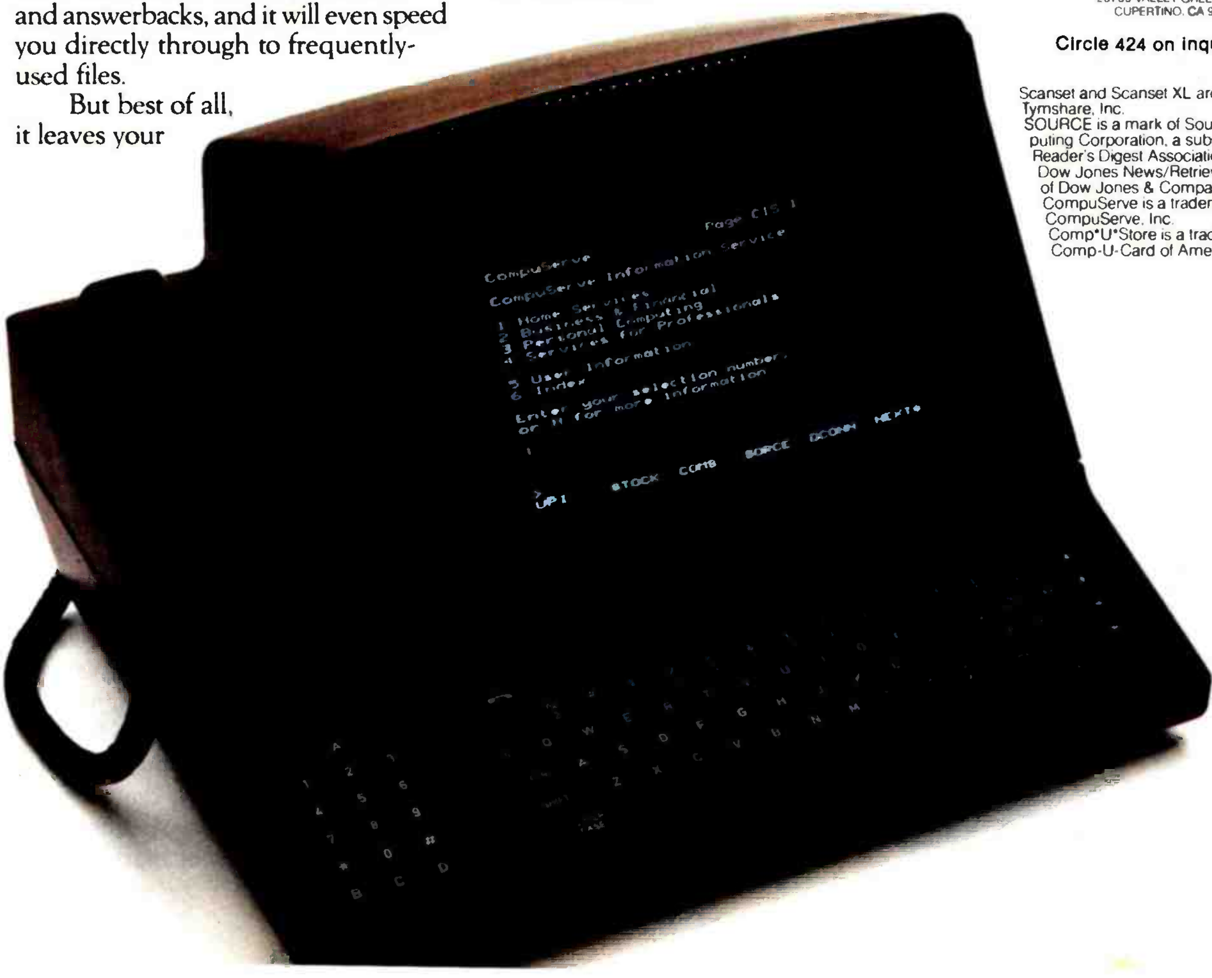

tinue to improve it. But there are two other areas that are becoming important now—the bit-mapped approach and the character I/O (input/output) approach. In the character I/O approach, you use the screen as a full screen, but you put only characters on it. You use highlighting and blinking and all the features of a typical video display, but you don't use graphics in the bit-mapped form.

Apple's Lisa and Visicorp's Visi On come under the bit-mapped approach. Digital Research is active in all three categories: the programmer's interface, the character I/O approach, and the bit-mapped I/O approach.

The advantage of the bit-mapped approach is that you can get optimum resolution and do very symbolic things like getting a trash can to symbolize dumping a file. However, if we have a bit-mapped screen with a bunch of windows and we're running different applications concurrently, it's not clear that the 8086 has enough power to update the screen in each window concurrently. It's my understanding that Visi On has all the hooks for concurrency built into it, but they're not implemented in the 8086 version because of that processor's inability to support those windows and concurrent processes at sufficient speed.

On the other hand, if we use character I/O rather than bit-mapped screens, there's no question we can swap screens out with an 8086 while running different programs concurrently. We've demonstrated that. The advantage of the character I/O approach is that you can get a lot of functionality and ease of use and still run the cheaper hardware and get good performance. So right now we're working predominantly on character I/O.

It's not common knowledge, but we're working very closely with Visicorp and selected OEMs (original equipment manufacturers) in the bit-mapped area to be sure that Visi On works correctly. Digital Research will help OEMs adapt Visi On to CP/M. In fact, DRI will help with the writing of Visihost for a particular machine.

We also have our own projects in the area of visual user interfaces, but that's all I can say about that for now. We're experimenting. We're trying to solve different problems of the user interface because we want to give the operating system an integrated look.

Operating System Markets

Look at how our operating system strategy is set up for the 8080 family and the 8086 family. The single user has a single-tasking or multiple-tasking operating system; larger, multiuser systems are achieved with multiple tasking on one central processor or networking on multiple central processors.

I've categorized the different operating systems by market segments. In the single-user, single-tasking segment, we have CP/M Plus for 8080s and CP/M-86 for the 8086 family. In the single-user, multitasking segment, we have MP/M II for 8080s and Concurrent CP/M for the 8086 family. For the multiuser, multitasking segment, we have MP/M II for 8080s and MP/M-86 for the 8086 family. In the multiuser, local-area network segment, we have CP/Net and CP/Net-86. Digital Research's strategy is to interface these operating systems through the user interface.

The segment that includes multiuser, multitasking systems is the traditional minicomputer market because minicomputers traditionally work in those environments. The segment that includes single-user systems, whether single- or multitasking, is the professional and small-business market. And the third segment is the local-area network.

We look at our competitors, MS-DOS and Xenix, and see them positioned in an area that really doesn't hit the marketplace. Microsoft is trying to stretch from MS-DOS, a single-user, single-tasking system, to Xenix, a multiuser, multitasking system, which is a totally different segment of the market. In other words, while it's technically good to say you'll migrate from MS-DOS to Xenix, that doesn't make sense from the marketing side. One of the principles of marketing is

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to look at the market segments you're in and then try to understand how your products fit in other segments. Well, moving Xenix into other segments doesn't make sense. It doesn't work in real time, it doesn't work on floppy disks right now, and it doesn't have file protection—not that you couldn't fix all these things.

In addition, I claim that people move from the single-user systems into networking rather than into the classic multiuser area. I see multiuser local-area networks of multitasking single-user systems developing rather than systems of many users on a single central processing unit. With this in mind, when we look at where we really think the appropriate products are, we think that CP/M Plus is the cornerstone product on the 8-bit. We don't think that the MP/M, 8-bit multiuser system is the predominant choice for the majority of users. We think that single-user single-tasking in the 8-bit world and single-user multitasking in the 16-bit world are the main areas, and networking between the two is crucial. And while we have systems for all market segments, we think that on the 8086 and 8088 concurrency is what will satisfy most of the professional and small-business users.

Of course there's the home segment and the industrial segment—all kinds of segments in which operating systems fit in. But right now we're concentrating on the professional/small-business segment.

Our experimenting with user interfaces applies here. Now when we go into a visual CCP (Console Command Processor), we don't just say we're going to put it on this one product. We've got to talk about putting it on at least all the CP/M market segments. Perhaps MP/M II could live without upgrades, although there is no problem integrating a visual CCP. The strategy is to have a uniform interface and perhaps alternate interfaces. As we develop more experience in that area, maybe we can come up with a different approach.

The 3.1 File System

The thing that's nice about our new products is that they all have what we call the 3.1 file system. It has protection, works in real time, and offers file and record-locking commercial features. (Of course, a single-tasking operating system, by definition, can't be a real-time system.) When you write programs in this environment, you can actually port them into the networking system; you can network. You could start with CP/M Plus, then get a DEC Rainbow and run Concurrent CP/M-86 on it, and then get the networking and network the 8-bit system. They'd all talk together. When we talk about a user interface, we're talking about putting it across a family of products. We're working on both approaches—bit-mapping and character I/O. It's not really complicated.

Pointing Devices

Some people ask us what we think of having a mouse. What we think isn't really the issue. What the public thinks is the issue. It will be interesting to watch what happens if we get the mouse into the schools. The kids get so good at these things, they just develop a capability.

Have you played video games? You get to where you just develop a feel for the joystick and how to do the game. If kids grow up learning how to use these things in school, mice will be second nature to them. The experts tell me that you can be very proficient with them.

I think touch screens and voice will be as big a factor as mice. One of the reasons we chose the virtual device interface (VDI) approach to graphics was that it's both an output and an input system. The definition allows input devices, so things like mice and joysticks become an integral part of the system that has GSX (an implementation of the graphics kernel standard that includes a virtual-device interface). There are two fundamental reasons why GSX or VDI is superior to, say, NAPLPS (North American Presentation-Level Protocol Standard) in the business segment. It's important not to confuse segments. GSX accepts input devices that are going to be important in the professional workstations, and it has a two-way communication with the interface. In other words, I don't just say "draw a line." I can ask how many colors and line styles are supported, get that input from the system, and make a decision on how to present the graph.

This leads to more portable software. If you're really going to talk about object-code portability and about supporting a number of machines, there are two ways of doing it. At present, the programmer sits down each time and makes a separate version of the program. Just feeding in the measurements and having the product come out would be an easier way. Now there is a little bit of a trade-off. You're never going to get the optimum custom fit that you get by writing new code for each machine, but how many of us have shirts made any more? I think it's going to be the same way with software. Things like GSX lend themselves to this type of portability.

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machine now, and when they do a new graphics board the program will still run. You write one driver and all the other programs run on it. In software I think it's important to get that kind of portability across a large number of machines, to last through two or three generations of machines, get good value for the money, and benefit the end user. Having this kind of portability is going to bring about low-cost software.

The Office Metaphor

I think people confuse ease of learning and ease of use. Someone really has to make it clear that those are different concepts. Wordstar is a great example. I hear people blast Wordstar all the time because it's hard to use. But it's really only hard to learn; once you learn it, it's not that hard to use. I think people are really big on ease of learning because it helps sell products. They blast Wordstar's Control C or Control F. I know where the keys are, but I don't think it's any easier to use some function keys. Especially on the IBM PC, where you get the first 10 by using F1 to 10 and others with combinations like Shift F1. How is that easier? I think function keys promote ease of learning but not ease of use, particularly for high-proficiency people who don't want to move their hands off the keyboard.

I also think that we spend a lot of time talking about control keys rather than talking about the keyboards themselves. Somebody ought to look at a Displaywriter keyboard and then a PC and analyze the difference in terms of ease of use for someone who has to type for eight hours a day. I've never typed all day, but I do spend three or four hours at a keyboard. Except for top-of-the-line word processors like Displaywriter, most keyboards are fatiguing. There's a big difference between the Displaywriter keyboard and, say, the PC keyboard. The PC is a nice keyboard—I don't think it's the best keyboard on the market, but it's okay.

The office metaphor—with filing cabinets, in-baskets, and so on—is very easy to learn because of the analogy. But once you have a computer, you probably find new ways of thinking about and doing things, ways that were never possible in an old office. In the same way, when IBM brought in all the tab machines and NCR brought in all its equipment back in the 1920s and 1930s, people developed new ways of doing things in the office. They had to. Without a typewriter and a Xerox machine, I don't know how we would function.

With word processors, people learned to take a different approach. Word processors make it a simple matter to work on rough drafts much more than you ever did before. You feel free at any point to mark things up, change one or two words. Before word processing if you had a 20-page document and you changed three or four words, you would have had a rebellion. You just couldn't do that.

Video Game Metaphors

One interesting thing we're looking at from video games is the attract mode, where you get a feel for the system by seeing it go through all the things it can do. Gary Kildall has two kids. Scotty, the teenager, is an ace at video games. He's really good at Donkey Kong. I can never get into the elevator part. I think that the influence of Scotty and his friends and other kids who like video games is showing up in the design of our software.

We have some really talented people trying to design different interfaces that work. There's definitely a commitment at DRI to the user interface both in bit-mapped and character I/O approaches. At the same time, we work with Visicorp very closely, and its interface will be available for CP/M-86 systems. The character I/O interfaces from Digital Research will be available by the end of 1983, and Visi On will be available in the middle of 1983.

I think that all these things will tie in to make available very good interfaces on CP/M operating systems. We have maintained very good working relationships with a large number of software houses, and cooperation among companies will make improvements in the user interface widely available. ■

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Continued from page 8

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SSM Microcomputer Products Inc., San Jose, CA, is distributing Transend PC, a $189 icon-based, user-friendly electronic-mail program for the IBM PC developed by Small World Communications of Menlo Park, CA. One of the program's authors, Richard Moore, worked on Smalltalk-based computers at Xerox PARC and on the Apple Lisa computer; both make heavy use of icons and emphasize ease of use.

VICTOR INTRODUCES LOCAL AREA NETWORK AND DISKLESS COMPUTER WORKSTATION

Victor Technologies has announced a local area network that allows hard-disk sharing and supports up to three printers, plotters, or other peripherals. The company will also offer a low-cost diskless computer workstation that can be combined with microcomputers on the network. Based on Corvus's Omninet, the network supports 54 workstations and 10 file servers at a speed of 1 megabit per second. The file servers offer a 10-megabyte hard disk, a floppy-disk system storing 1.2 megabytes, and 256K bytes of RAM for $5495.

MICROSOFT, SUMMAGRAPHICS, AND MOUSE SYSTEMS DISPLAY THREE NEW MICE

Microsoft announced its two-button mechanical mouse, which will work with Multiplan and Microsoft's new word processor, Multi-Tool Word. The mouse will sell for $195 with two educational programs and Multi-Tool Notepad, a simple text processor. Summagraphics, the bitpad manufacturer, displayed the Summa Mouse, a three-button optical device, to be used with Visi On. It will sell for $300. Mouse Systems, Santa Clara, CA, has created a mouse for the IBM PC that can be used with existing commercial software, translating mouse movements and button presses into user-definable code sequences.

KODAK PRESENTS ULTRA-HIGH-DENSITY FLOPPY DISKS

Eastman Kodak's Spin Physics division, San Diego, CA, showed samples of its new Isomax ultra-high-density floppy disks. Cobalt-doped isotropic magnetic particles allow vertical recording (using small-gap recording heads) with each disk, potentially storing 5 megabytes at 96 tracks per inch. The most interest, Kodak reports, has been in 5¼-inch disks, which have sold for under $30 each in small sample quantities, but samples have also been produced in three microfloppy sizes. Full production is scheduled by the end of 1983.

GREAT LAKES COMPUTER PERIPHERALS CO. OFFERS 10 MEGABYTES FOR LESS THAN $1000

The Great Lakes Computer Peripherals Co., Schaumberg, IL, announced the availability of its Magnabyte-10, a 10-megabyte hard-disk unit for the IBM PC and PC-bus compatible systems running under PC-DOS 2.0. An enclosed unit, the Magnabyte-10 comes with power supply, disk-controller card, and cables. It also has room for another 10-megabyte hard disk in the case. Price of the single-drive unit is $995; the dual-drive unit sells for $1795.

AMLYN AND SONY ANNOUNCE HIGH-DENSITY DISK DRIVES

Amlyn Corp. announced 5¼-inch floppy-disk drives that can store 3.3 megabytes of data using double-sided recording at a density of 9500 bits per inch at 170 tracks per inch. The drives use an Intel 8051 microprocessor to handle real-time control functions, including the ability to read disks recorded at standard track densities such as 48, 96, or 100 tpi. Sony introduced another entry in the "smaller is larger" category with a double-sided version of the 3½-inch microfloppy disk drive that can store 1 megabyte of data.

CONTROL DATA'S 'CRICKET' WINCHESTER STORES 6 MILLION BYTES

Control Data Corp. introduced several OEM disk-drive products at the show, including the CDC 9270-6 "Cricket," a 3½-inch Winchester hard-disk drive that uses thin-film heads and nickel-cobalt-plated disks to provide personal computer users with 6.38 million bytes of unformatted data storage. The Cricket is compatible in timing and format with the industry-standard Seagate ST506 interface, which transfers data at 5 megabits per second. The complete disk drive, which incorporates a band-stepper positioning technique, is 1.63 inches high, 4 inches wide, and 6.37 inches deep. Linear recording densities are 15,390 bits per inch and 450 tracks per inch. Developed by the technology division of Magnetic Peripherals Inc., a CDC subsidiary, the Cricket will be available for OEMs in evaluation quantities in the third quarter for $465.

MANNESMANN TALLY INTRODUCES THE SPRITE, A NEW LOW-COST PRINTER

Mannesmann Tally, Kent, WA, has introduced a low-cost printer, the Sprite, for $399 and has reduced the price of its MT 160 printer by 25 percent, to $698. Both printers emulate the popular Epson MX-80 in character and graphics modes. The Sprite is an 80-cps printer with a full-spaced 9 by 8 dot matrix, a parallel interface, and friction and tractor feed. The MT 160, when combined with a $100 option, produces near-typewriter quality printing in a two-pass mode with various text-formatting capabilities. Both versions of the MT 160 print at 160 cps.

DEC DEMONSTRATES AN INTERACTIVE VIDEO INFORMATION SYSTEM

Digital Equipment Corp. showed an optional enhancement to the Professional 350 computers: IVIS, the Interactive Video Information System. Still-frame or dynamic video signals from either of two NTSC (National Television System Committee) sources can be superimposed or intermixed with bit-mapped 960- by 240-pixel text and color graphics on a 13-inch RGB monitor, accompanied by two audio channels. Education and video production are two expected applications for the system. An IVIS-equipped Professional sells for $12,624.

MYSTERY GAME PUTS DETECTIVES ON BLIMP

Murder on the Zinderneuf, a video game from Electronic Arts, lets amateur sleuths assume the role of their favorite detective to solve a new mystery with each game. Game players uncover clues by questioning the other passengers on the Zinderneuf, a dirigible. Answers vary with the detective and style of questioning the player chooses. The game sells for $40 and is available for Atari 400, 800, and 1200 XL.

IBM OFFERS PLASMA DISPLAY AND 4-INCH DISK DRIVE

IBM showed two interesting, if curious, products. One, a plasma display running on an IBM PC, measures 16 by 12 by 2½ inches and has a resolution of 960 by 768 pixels (about 71 dots per inch). The display is bright red, and it can produce some striking graphics. The display is being offered to manufacturers at about $3400 in single-unit quantities. The other IBM product is a 4-inch floppy-disk drive. The drive uses a French-curve shaped cam to position the recording head and uses no track sensors to position the head. The speed changes for each track so that the medium passes the head at the same speed for each track. The drive can store 250K bytes on a single-density single-sided disk at 68 tracks per inch and 6865 bits per inch. The disk looks like the 5¼-inch variety except that the disk envelope and sleeve are made of hardened plastic.

CANON UNVEILS A SEVEN-COLOR INK-JET PRINTER

Canon displayed a seven-color ink-jet printer, the A-1210, which sells for about $795. The print head for the Canon uses four nozzles and prints 40 characters per second. Graphics resolution is 640 dots per line. The printer uses plain roll paper, 8½ inches wide.

NANOBYTES

Epson announced three additions for the portable HX-20 Notebook Computer: The Skiwriter word-processing software, a microcassette drive, and Typing Tutor. The word-processing package is available in ROM format and features a context-sensitive HELP facility. . . . **Hewlett-Packard is offering** four new plug-in software packages for its HP-75C portable computer, giving users a full-featured Visicalc, Text Formatter, Math Pac, and Surveying Pac. . . . **Micropro is giving away** a CP/M board for the Apple II and IIe with the purchase of Wordstar or Infostar. . . . **Seeq Technology** of San Jose, CA, will announce this month that its EEROMs (electrically erasable read-only memories) can be rewritten 100,000 times. In effect, this provides reprogrammable nonvolatile semiconductor memory. . . . **The Alien Group**, New York, NY, has created the Sprinter, a $580 62K-byte intelligent buffer that allows users to dump a document to the buffer and interactively display it on a video monitor. A 12-key keypad allows scrolling within the stored document to print selected portions. . . . **Polaroid announced a low-cost** interactive film recorder that produces 35mm slides and instant photos of personal computer screen graphics. The Polaroid palette will be available later this year in Apple and IBM PC versions for $1300. . . . **Both Tecmar and Persyst**, makers of add-on boards for the IBM PC, announced versions of their products for the Texas Instruments Professional Computer. . . . **Koala Technologies Corp.**, Los Altos, CA, introduced an IBM PC version of its Koalapad nonkeyboard input device and Koalaware graphics software.

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The 8086—An Architecture for the Future

Part 2: Instruction Set

The 8086 lets you easily construct compact programs

by Stephen A. Heywood

High-level languages have been introduced over the years to ease the burden of programming. These languages consist of statements in a form more understandable by humans, as opposed to assembly language and machine code. But these statements still must be translated into machine code—the language the computer understands. For most high-level languages, the translation process involves the use of a compiler.

A compiler's code should be efficiently produced so that it doesn't occupy a large amount of memory space and executes quickly. Depending on the machine code needed by the microprocessor, this translation might or might not be an easy task for the compiler.

In part 1, I discussed how the method of addressing memory to access variables, using a segment and an offset, supported the high-level-language needs for memory-based variables. Table 1 reviews the 8086 addressing modes. The 8086 16-bit data structure and registers fulfill the larger data-type needs. In this part, I will explore how the instruction set assists high-level-language compilers in their task.

Instructions

Instructions can have no operands, one operand, or two operands. Most two-operand instructions follow the convention of the destination followed by the source, as used in the 8080 microprocessor. For example, the instruction ADD BX,AX means add the source and destination together (AX and BX) and place the result in the destination (BX).

Most instructions in the 8086 set operate on either bytes or words. Registers, immediate data, and memory contents can be designated as the source or destination in many operations; however, immediate data can only be the source. This capability lets you add 5 to the contents of a memory location and store the result back in memory. It also aids you in manipulating variables in high-level languages. Instead of having to write the intermediate steps to bring a memory variable into a register for manipulation and then storage, you can accomplish it in one instruction.

The 8086 uses general-purpose mnemonics, instead of one for each op code, with the operands defining the type of operation. For example, the 8086 mnemonic MOV (move) replaces such 8080 mnemonics as LDA, STA, LXI, MVI, and STAX, among others. This replacement means fewer mnemonics for you to remember and lets you concentrate on the program itself.

Many 8086 instruction mnemonics resemble those of the 8080, but with increased capabilities. This similarity permits easy conversion of 8080 assembler code to that of the 8086. Conversion programs take 8080 assembler code and convert it to 8086 assembler code for reassembly. The converted programs are larger and do not take full advantage of the 8086's instruction set, but do allow a quick way to upgrade 8080 software to the 8086.

Several new operations in the 8086 instruction set achieve the following added capabilities:

- multiplication and division of signed, unsigned, and unpacked decimal numbers
- string operations such as moves, scans, and compares
- byte translations using tables
- software interrupts
- program-loop instructions
- multiprocessor and coprocessor coordination
- nondestructive bit testing

The various addressing modes and instruction types combine to make a large number of distinct instructions. It would be tedious to program in machine language, which requires us to manually combine addressing mode and instruction type for each instruction we use. Because computers excel at tedious tasks, assemblers and high-level-language compilers are recommended programming tools.

Data-Transfer Instructions

The data-transfer instructions, as listed in table 2, provide the means to

Mode	Location of Data	Examples Using Add
Immediate	Within instruction	ADD CH,5F
Register	In register	ADD BX,DX
Direct	At memory location pointed to by offset contained in instruction	ADD WVAR,BX
Register Indirect	At memory location pointed to by offset contained in register	ADD CX,[BX]
Indexed or Based	At memory location pointed to by sum of index or base register contents and displacement in instruction	ADD [SI + 6],AL
Based and Indexed with Displacement	Memory address is sum of base register contents and index register contents and displacement	ADD [BX + DI + 5],DX

Table 1: *The 8086 addressing modes supply the operands for the instructions. To access variables for instructions, the 8086 uses its addressing modes to generate the offset for memory variables. The full address for memory variables consists of the contents of a segment register plus the addressing mode.*

Mnemonic	Description of Operation
MOV dest, source	Move byte or word
PUSH source	Push word onto stack
POP dest	Pop word off stack
PUSHF	Push flags onto stack
POPF	Pop flags off stack
XCHG op1, op2	Exchange operand 1 with operand 2
LAHF	Load AH register from flags
SAHF	Store AH register in flags
IN acc, port	Input byte or word to accumulator
OUT port, acc	Output byte or word in accumulator
LEA dest, source	Load effective address
LDS dest, source	Load pointer into destination and DS
LES dest, source	Load pointer into destination and ES
XLAT	Translate byte

Table 2: *The data-transfer instructions set up registers or memory locations, communicate between the 8086 and input/output devices, save to the stack and retrieve that information, and translate data from one form to another.*

set up registers or memory locations, communicate between the 8086 and I/O (input/output) devices, save to the stack and retrieve that information, and translate data from one form to another. Only the POPF (pop flags off stack) and SAHF (store AH register in flags) instructions affect the flag register; the remaining data-transfer instructions have no effect on the flags.

The MOV instruction is a nondestructive copy of the source operand (the second operand) to the destination operand. The source and destination are either bytes or words and can be register or memory contents using the addressing modes, but both cannot be memory contents. The source can also be immediate data, which satisfies the need to set up registers and variables in memory. For example, you might want to set up a variable in memory called HOUR with a value of 5. The instruction would then look like this in the program:

```
MOV HOUR,5
```

with the offset in memory in place of HOUR.

The PUSH (push word onto stack) and POP (pop word off stack) instructions provide a way of saving and restoring the contents of a register, the contents of a memory location using the addressing modes (not immediate data), or the contents of the flag register (using the PUSHF

Printers

Software compatability is crucial in choosing any printer, so before you decide, check that your software can work with a given printer. This is *your* responsibility, not ours.

Interfacing with most micros is a choice between parallel or RS-232C (serial). Be sure you know which type your computer handles. Wherever possible, use the parallel option. It's easier to use & it cost less too.

C. ITOH

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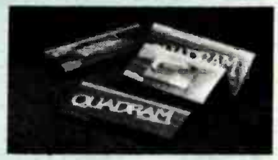

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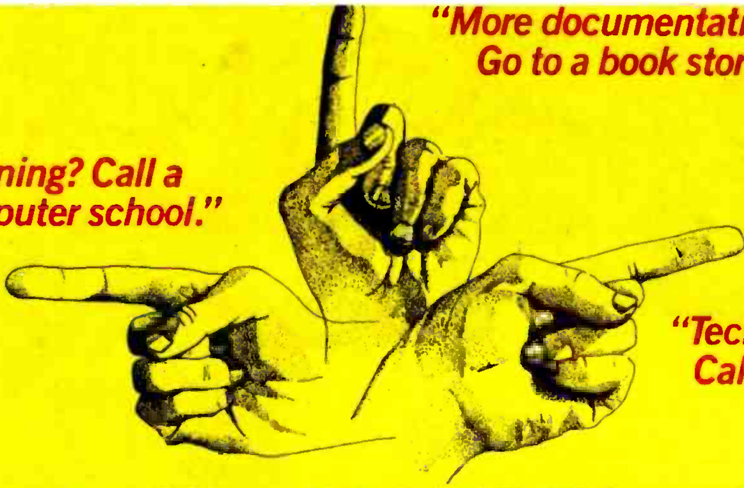
MILFORD, NH 03055-0423 □ TELEPHONE (603) 881-9855 [push flags onto stack] and the POPF instructions). These operations use the stack. The stack is pointed to by the SS (stack segment) register; the SP (stack pointer) register points to the top of the stack (the last word placed on the stack). All stack operations must consist of 16-bit words. In figure 1, a PUSH operation decrements the SP register by 2 and then writes the word; a POP operation reads the word from the stack and increments the SP by 2. Words are written in memory by the standard Intel convention of the low byte in the lower address and the high byte in the higher address. Being able to use PUSH to place memory contents on the stack proves useful when we later look at passing parameters to procedures.

Operations PUSH, POP, and MOV let you use a segment register as one of the operands. For MOV, you can employ any of the addressing modes, except immediate, for the source, with the destination as a segment register. This permits you to set up the segment registers at the start of the program.

Because you would want to only set up the registers and then leave them alone, data transfers are the only instructions allowed to change DS (data segment), ES (extra data segment), and SS. Because CS (code segment) is the segment register for accessing instructions with the IP (instruction pointer) register supplying the offset, you would not want to change CS alone. Therefore, the data-transfer instructions cannot use the CS register as the destination; instead, you would use program transfers, such as JMP (jump) or CALL (call), to change CS and IP together.

Figure 2 shows a sample program that sets up the segment registers to point to certain locations. Recall from part 1 that the contents of the segment registers are the most significant 16 bits of the absolute 20-bit address. To set up the segment register, you would either use MOV to transfer an immediate value to a general register and then move that value into the segment register, as shown in the example, or have that value in a memory table. Notice that the SP

Text continued on page 307



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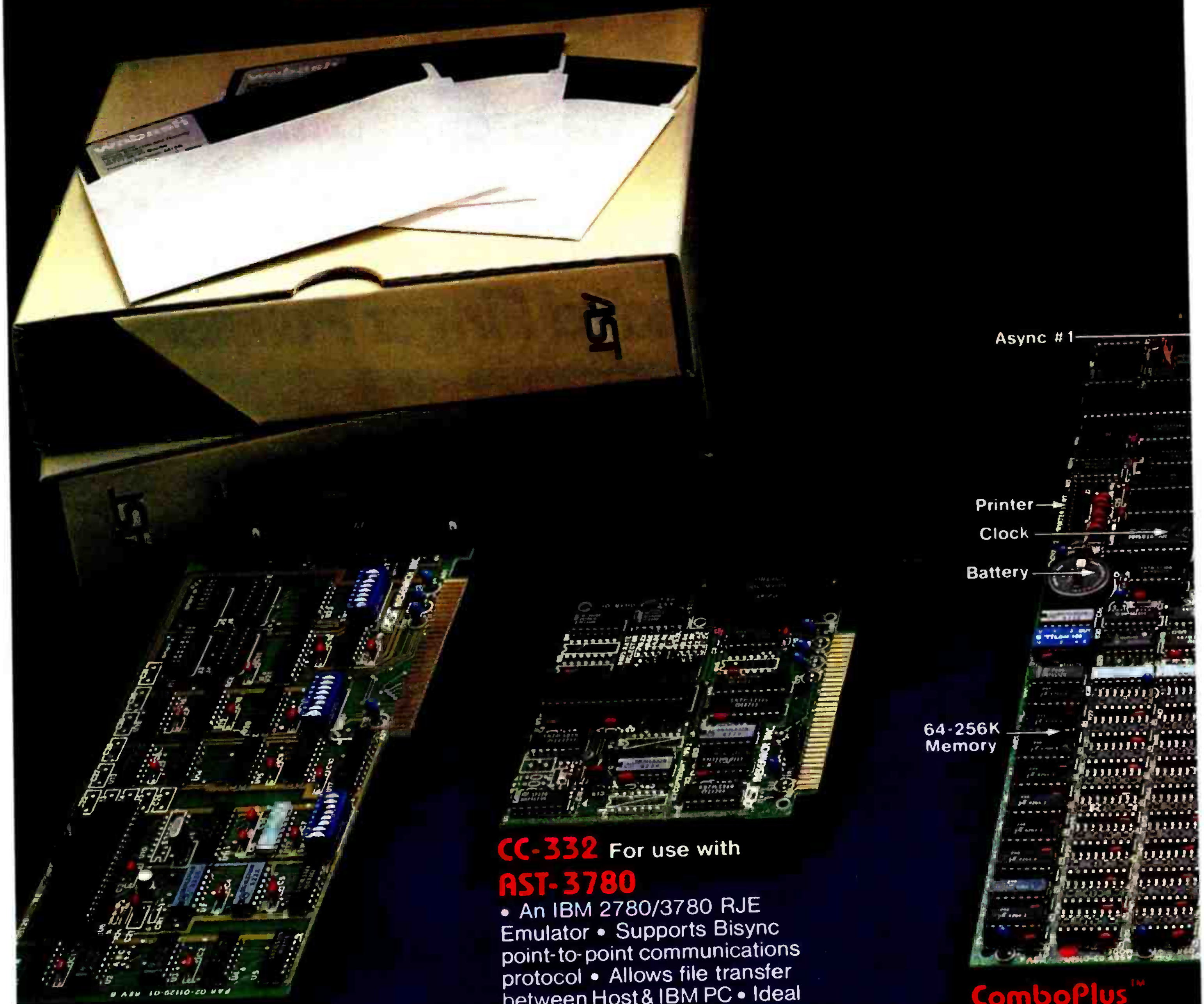

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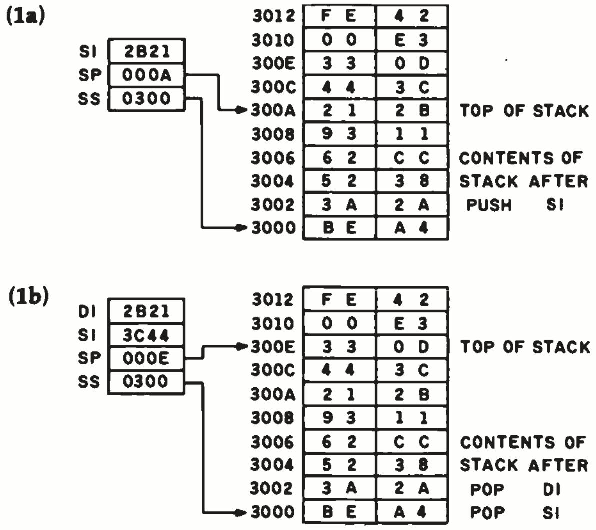

Figure 1: *PUSH and POP on the 8086. Given that the stack pointer (SP) points to location 3008 hexadecimal, figure 1a shows the status of the processor after the execution of PUSH SI. Figure 1b shows the processor after the additional instructions POP DI and POP SI are executed. In stack operation, the PUSH instruction decrements the stack pointer by 2 and then writes the word on the stack. The POP instruction reads the word from the stack and then increments the stack pointer by 2. Words are written low byte first. Note also that the SS register does* not *point to the "bottom" of the stack.*

```
MOV  AX,2000  ;Most significant 16 bits
MOV  DS,AX    ;of data area in DS
MOV  AX,6534  ;Same for stack
MOV  SS,AX    ;Follow move to SS with
MOV  SP,0200  ;move to SP
JMP  BEGIN    ;This will load CS and IP
              ;with the start of first
              ;instruction
```

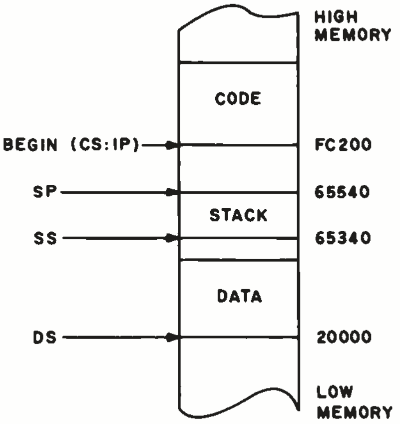

Figure 2: *This is an example of segment-register initialization. The SP register should be loaded directly after the SS register to make sure that the stack is pointed to correctly.*

register is loaded immediately following the loading of the SS register. (You should follow this example in your 8086 programming.) The 8086 disables interrupts for one instruction following any move into the SS register. If you follow these steps, the stack will not be pointed to incorrectly in case an interrupt occurs. Most segment setups would be done in a small program by itself, like the example, and that program would jump to the beginning of the actual code. Therefore, programs can be loaded anywhere in memory.

The instructions PUSH and POP can also be used to save and restore segment registers, as well as make them point to the same location. For example, to make the ES register point to the same memory area as the DS register, you could do this:

```
PUSH DS
POP  ES
```

The XCHG (exchange) instruction swaps the contents of the two operands, which can be general registers or memory contents (but both cannot be memory contents). Furthermore, XCHG cannot specify a segment register as an operand.

Also recall from part 1 that the low byte of the 8086 flag register is a bit-for-bit copy of the 8080 flag register. In addition, the 8086 allows easy conversion of 8080 assembler code to 8086 assembler code. To accommodate some of the instructions that affect flags differently, LAHF and SAHF are provided. The LAHF instruction loads the lower byte of the flags into the AH register, and the SAHF instruction stores the AH register into the flag register's lower byte. Figure 3 depicts this operation.

Figure 4 illustrates how the 8086 registers are used by conversion programs. For example, the 8080 instruction DCX D decrements register pair DE but does not affect the flags. By contrast, the 8086 equivalent DCR DX instruction does affect the flags. A conversion program would change the 8080 DCX D instruction to an LAHF, followed by a DCR DX and then an SAHF. When this new assembler code is reassembled with an 8086 assembler and run on an 8086 system, the flags would appear unaffected after execution of these three instructions.

To deal with I/O devices, you could address them like memory devices and use MOV instructions to transfer data to and from them. But this would detract from the 1 megabyte of available memory space.

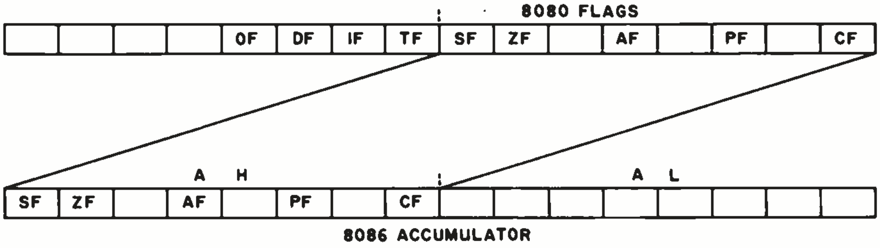

Figure 3: *LAHF loads the AH register with the low byte of the flags, and SAHF loads the low byte of the flag register with the contents of AH. These instructions are included in the 8086 instruction set to accommodate conversion programs from 8080 to 8086.*

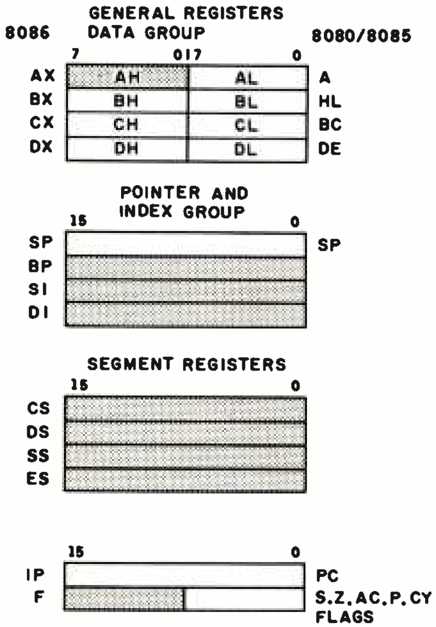

Figure 4: *Shown is the 8080/8085 register subset of the 8086. The nonshaded registers are those used by conversion programs when converting programs from the 8080 to the 8086.*

Therefore, provided in the 8086 instruction set are the IN and OUT instructions, which give I/O devices their own special addressing space separate from memory.

You call each address a port to clarify the difference between memory addresses and I/O device addresses. The IN and OUT instructions let you talk to 65,536 ports. The AL register transfers bytes using the upper or lower 8 bits of the data bus. The AX register transfers words that occupy the entire 16-bit data bus and take two consecutive port locations. You can use only these registers to do transfers with these instructions. No segment register is used in port addressing, and a special 8086 pin designates a memory access or an IN/OUT instruction port access.

The two types of IN/OUT instructions are direct and indirect. The direct instructions supply a 1-byte port address. This gives you the capability to access ports at I/O addresses 0 through 255. The indirect instructions employ the DX register to hold the port address of the I/O device. Using DX gives you the capability of addressing the 65,536 ports. The ability to manipulate DX with arithmetic instructions enables you to communicate with several consecutive I/O ports. The IN/OUT instructions are the only instructions that use the DX register as a pointer.

The address-object data-transfer instructions (LEA, LDS, and LES) load addresses into registers. However, the source operand must be in memory, and the destination must be a general register. The LEA (load effective address) instruction loads a general register with the offset of a variable instead of its contents. Because you can use the memory addressing modes, you could have the sum of calculations made on a base register and an index register with a given displacement. Instructions LDS (load pointer into DS) and LES (load pointer into ES) load a general register and either the DS or ES register with a 32-bit pointer found in two consecutive memory words. String operations and procedures make use of LDS and LES to set up pointers to a working area.

Often you need to translate data in a computer from one form to another, for example, converting ASCII to EBCDIC, Fahrenheit to Celsius temperature, etc. Included in the 8086 instruction set is a translate instruction, XLAT, which simplifies the job. XLAT replaces a byte of data in AL with a byte from a table. The table starting location is pointed at by the BX register, and the contents of AL are the displacement into the table. Figure 5 describes an example program with a diagram of how the XLAT instruction works. You load BX, using the LEA instruction, with the starting location of the table and the DX register with the port address to input the data. The data brought in is then translated to the data needed.

Arithmetic Instructions

The 8086 arithmetic instructions, as listed in table 3, can operate on signed numbers, where the most significant bit represents whether the number is a two's-complement negative or positive, unsigned numbers, and decimal numbers. Most arithmetic instructions affect the flags as follows:

CF (Carry flag): If set, indicates a carry out of, or a borrow into, the high-order bit of the result.
AF (Auxiliary Carry flag): If set, indicates a carry out of, or a borrow into, the low-order half-byte of the result. It is used for the decimal-adjustment instructions.
SF (Sign flag): This flag is a copy of the most significant bit of the result.

```
;This program will input a value from
;a keypad at port 0100 and convert the
;values from 0-F to the ASCII representation
;of that value
LEA   BX,TABLE    ;Offset of table in BX
MOV   DX,0100     ;DX contains port
                  ;number
IN    AL,DX       ;Get data from keypad
                  ;using indirect INput
XLAT              ;Using data input to AL
                  ;as displacement get
                  ;ASCII data and place
                  ;back in AL
```

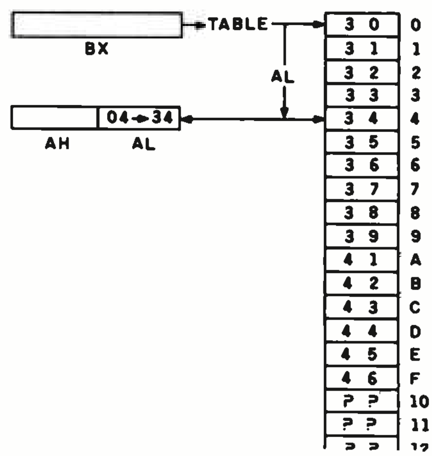

Figure 5: *This program uses the XLAT instruction to convert a single hexadecimal digit to its ASCII equivalent (e.g., to convert the value 04 into 34 hexadecimal, which is the ASCII code for the character "4"). XLAT uses the contents of the AL register as a displacement into a lookup table pointed to by the BX register. The contents of the location then replace the contents of the AL register. The values in the table are in hexadecimal.*

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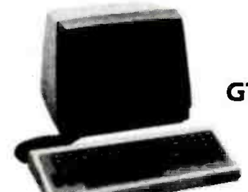

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Mnemonic	Description of Operation
ADD dest, source	Add byte or word
ADC dest, source	Add byte or word with carry
SUB dest, source	Subtract byte or word
SBB dest, source	Subtract byte or word with borrow
INC dest	Increment byte or word by 1
DEC dest	Decrement byte or word by 1
NEG dest	Negate byte or word (two's complement)
CMP dest, source	Compare byte or word
MUL source	Multiply byte or word unsigned
IMUL source	Integer multiply byte or word
DIV source	Divide byte or word unsigned
IDIV source	Integer divide byte or word
CBW	Convert byte to word
CWD	Convert word to double word
DAA	Decimal adjust for addition
DAS	Decimal adjust for subtraction
AAA	ASCII adjust for addition
AAS	ASCII adjust for subtraction
AAM	ASCII adjust for multiplication
AAD	ASCII adjust for division

Table 3: *The 8086 arithmetic instructions operate on signed, unsigned, and binary-coded-decimal numbers.*

ZF (Zero flag): This flag is set if the result is equal to 0.
PF (Parity flag): This flag is set if the low-order 8 bits of the result contain an even number of 1s. It is kept in the 8086 for 8080 compatibility.
OF (Overflow flag): This flag is set if the result is too large a positive or too small a negative value to fit into the destination without changing the sign incorrectly.

The ADD (add), ADC (add with carry), SUB (subtract), and SBB (subtract with borrow) instructions are the standard addition and subtraction instructions that add and subtract bytes or words for multiple precision. Any general register, memory location, or immediate data can be the source added with, or subtracted from, the destination, with the result placed back in memory or in a general register designated as the destination.

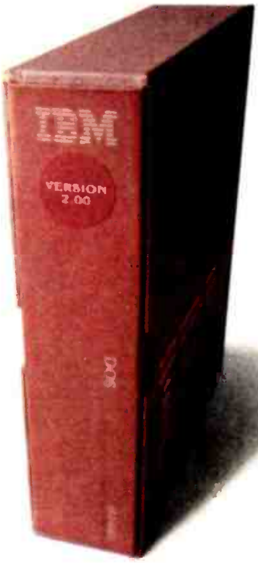
Instructions INC (increment) and DEC (decrement) have only one operand, which can be a general register or memory contents; they are the same as adding or subtracting 1, but with no effect on carry.

Instruction NEG (negate) subtracts the operand from 0. This is the same as taking the two's complement of a number, i.e., changing it from positive to negative. If the byte to be negated is equal to −128 (80 hexadecimal) or the word is −32,768 (8000 hexadecimal), then the result shows no change, but the Overflow flag is set.

Instruction CMP (compare) is the same as SUB except that the result is not placed anywhere. Instead, the flags reflect the same result as if a subtraction had taken place. After a CMP operation has been performed, you would use a conditional jump, which checks the flags to determine whether the destination operand is larger, smaller, or equal to the source.

With earlier microprocessors, programmers had to write or use algorithms, or miniprograms, to perform a function, in order to perform multiplication and division. The 8086 has multiply and divide instructions built into its instruction set to make programming easier.

The multiply and divide instructions employ dedicated registers for their destination register, as shown in figure 6. To multiply by a byte, the AL register must hold one of the operands, with the result placed in AX. AX is used to hold the result because it may be larger than one byte can hold. To multiply by a word, you would use the AX register



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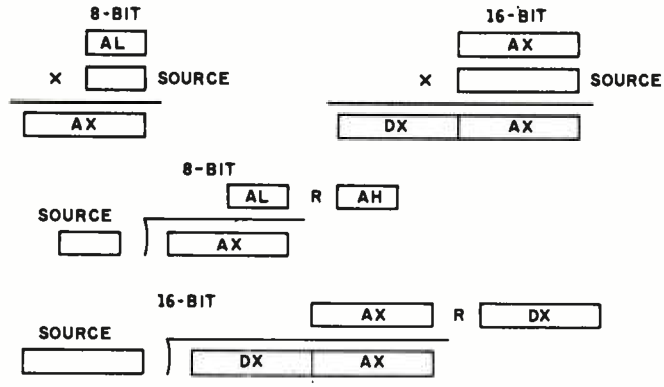


```
;This program will perform the formula
;AX = (BH × BL) + (CH/CL) with
;BH = FB (-5), BL = FE (-2)
;CH = EC (-20), and CL = 05 (+5)
MOV  AL,BH        ;AX = ??FB—note only AL loaded
IMUL BL           ;AX = 000A (+10) = -5 × -2
MOV  DX,AX        ;Temporary save result
MOV  AL,CH        ;AX = 00EC (-20)
CBW               ;AX = FFEC—converted to word
IDIV CL           ;AX = 00FC (-4) in AL
CBW               ;AX = FFFC—converted to word
ADD  AX,DX        ;AX = 0006 (+6)
```

Figure 6: *The 8086 multiply and divide instructions use dedicated registers for one of the operands and to hold the results of the operation.*

to hold one of the operands, with the double-word result placed in registers DX,AX and the most significant word in DX. Division operates the opposite, with the double-word divisor in DX,AX for division by a word, the quotient in AX, and the remainder in DX. Byte division places the divisor in AX, the quotient in AL, and the remainder in AH. The source operand specified in the instruction can be a general register or memory location using the addressing modes, but you cannot use immediate data.

Two types of multiply and divide instructions are available: MUL (multiply) and DIV (divide) for unsigned and IMUL (integer multiply) and IDIV (integer divide) for signed. Because the results are different for signed and unsigned, i.e., a negative times a negative is a positive, these four operations are included to cover each type.

The flags react differently for multiplication and division than they do for other arithmetic operations. For multiplication instructions, status flags CF and OF are set if the upper half of the result (AH for byte or DX for word) contains part of the result. This means that AH or DX is nonzero for unsigned or not just the sign extension of the lower half of the result for signed. The remaining status flags are undefined after a multiplication, and all the status flags are undefined after a division.

If a division result has more bits than the quotient (it can't fit in the AL register for a byte or in the AX register for a word), an automatic type 0 interrupt is generated. The quotient is undefined when this interrupt occurs. This saves you from checking the operands to be divided so that a division by 0 or dividing a very large number by 1 will not occur.

If the two operands do not evenly divide, then the quotient is rounded toward 0, and the remainder has the same sign as the quotient. In other words, if you divide a −5 by 2, then the quotient is −2 with a remainder of −1; likewise, dividing 5 by 2 equals 2 with a remainder of 1.

Division works fine after a multiplication because the AX or DX,AX registers contain the operands needed to divide by a byte or a word. But if you need to divide a byte by a byte or a word by a word, you begin to have problems. If you are using unsigned

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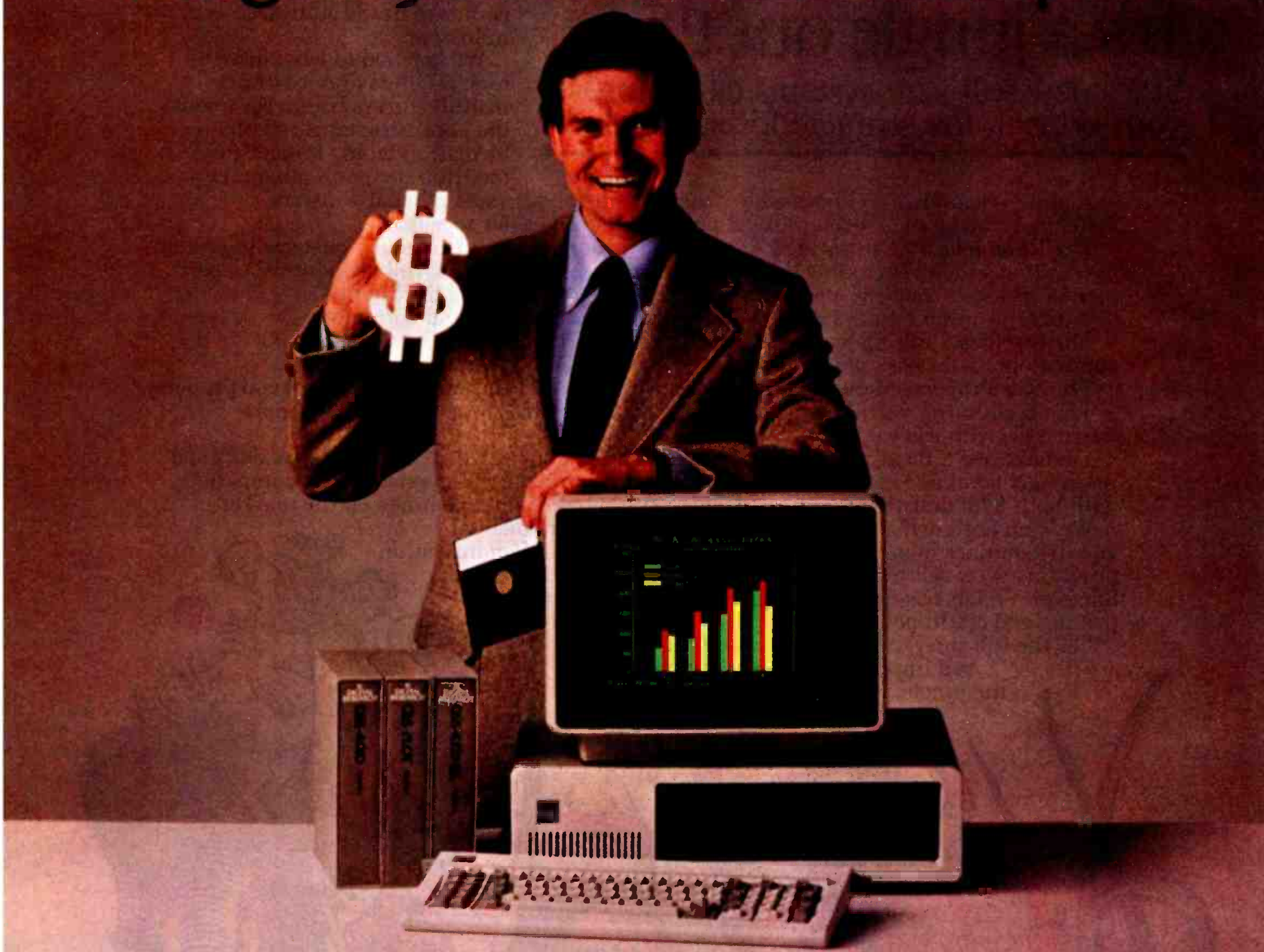

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division, then AH or DX is zeroed before the division to extend the dividend to the proper size. Signed division is a different story. If the number you're dividing by is positive, then AH or DX has to be zeroed; if the number you're dividing by is negative, then AH or DX has to be all 1s to get the proper word or double word.

Added to the instruction set are two instructions, CBW (convert byte to word) and CWD (convert word to double word), to take care of this decision making. Instruction CBW extends the sign of the AL register to the AH register, which effectively converts a byte to a word. Instruction CWD extends the sign of the AX register to the DX register or converts a word to a double word. Neither instruction affects the flags. The sample program in figure 6 demonstrates how signed multiplication and division operate with the contents of the AX register. Notice that CBW and CWD are not reserved only for division. In the program, CBW is used a second time to extend the sign of the byte in the AL register so that you can add the DX register to the AX register. If this wasn't done, the result would be 0106 hexadecimal instead of 0006 hexadecimal.

The 8086 can also perform decimal arithmetic. These numbers can be packed BCD (binary-coded decimal) numbers for addition or subtraction or unpacked BCD numbers for addition, subtraction, multiplication, or division. Packed BCD numbers are two BCD digits, hexadecimal representations of 0-9, contained in one byte. Unpacked BCD numbers contain one BCD digit in the lower half-byte with the upper half-byte zeroed. Unpacked BCD numbers are similar to the ASCII (American National Standard Code for Information Interchange) representations of numbers, except that ASCII numbers have a hexadecimal 3 in their upper half-byte instead of 0. To use ASCII numbers as unpacked BCD numbers, you must zero the upper half-byte and then set the upper half-byte to a hexadecimal 3 after the arithmetic operation and adjustment to get a valid ASCII number again.

Mnemonic	Description of Operation
NOT dest	"Not" byte or word (one's complement)
AND dest, source	"And" byte or word
OR dest, source	"Inclusive-OR" byte or word
XOR dest, source	"Exclusive-OR" byte or word
TEST dest, source	"Test" byte or word
SHR dest, count	Shift logical right byte or word
SAR dest, count	Shift arithmetic right byte or word
SHL/SAL dest, count	Shift left byte or word
ROR dest, count	Rotate right byte or word
RCR dest, count	Rotate through carry right byte or word
ROL dest, count	Rotate left byte or word
RCL dest, count	Rotate through carry left byte or word

Table 4: *These 8086 bit-manipulation instructions perform the logical operations as well as the shifts and rotations of bytes or words in memory or registers.*

Called the decimal-adjust instructions, DAA (decimal adjust for addition) and DAS (decimal adjust for subtraction) work with packed BCD numbers. The DAA instruction adjusts the contents of the AL register after the addition of two packed BCD numbers; the AL register must be the destination of the addition. The DAS instruction works the same way after the subtraction of two packed BCD numbers. All the status flags are updated, except for the OF flag, which is left undefined.

The ASCII adjust instructions work with unpacked BCD numbers. Instruction AAA (ASCII adjust for addition) changes the contents of AL to a valid unpacked decimal number, with the upper half-byte zeroed, after the addition of two unpacked BCD numbers. Instruction AAS (ASCII adjust for subtraction) works the same for subtraction. The AF and CF flags are updated after these instructions, but the remaining flags are left undefined.

Instruction AAM (ASCII adjust for multiplication) corrects after the multiplication of two valid unpacked BCD numbers, with the result in AH and AL. After AAM, the high-order unpacked BCD number is in AH and the low-order unpacked BCD number is in AL. Status flags PF, SF, and ZF are updated after this instruction, but the remaining flags are left undefined. Instruction AAD (ASCII adjust for division) modifies the contents of the AL register before a division takes place. The flags are affected the same way as for AAM. However, you must do an AAD first to ensure that, after the division is done, the result is a valid unpacked BCD quotient and remainder.

Bit-Manipulation Instructions

Table 4 lists the 8086 bit-manipulation instructions. These instructions perform the logical operations as well as the shifts and rotations of bytes or words in memory or in registers.

The logical instructions perform the Boolean operations. These operations are NOT, AND, Inclusive-OR, and Exclusive-OR (XOR). You can use the AND instruction to clear or mask out certain bits, the OR instruction to set certain bits, the XOR instruction to complement certain bits, and the NOT instruction to complement all the bits. The XOR instruction can also clear a register simply by Exclusive OR-ing the register with itself (i.e., XOR SI,SI).

The AND, OR, XOR, and TEST instructions affect the flags as follows: OF and CF are cleared; AF is undefined; SF, ZF, and PF reflect the result and can be tested by conditional jumps. The NOT instruction has no effect on the flags.

The TEST instruction is a nondestructive AND, which means it performs the AND operation but with no result. Only the flags are affected by this instruction. This lets you check for certain bits to be set or cleared in memory or in registers. For example,

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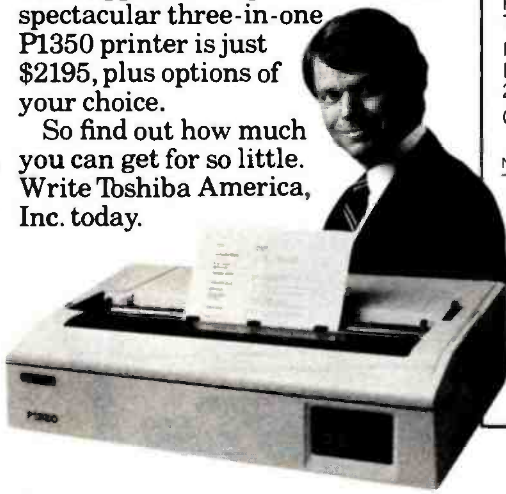

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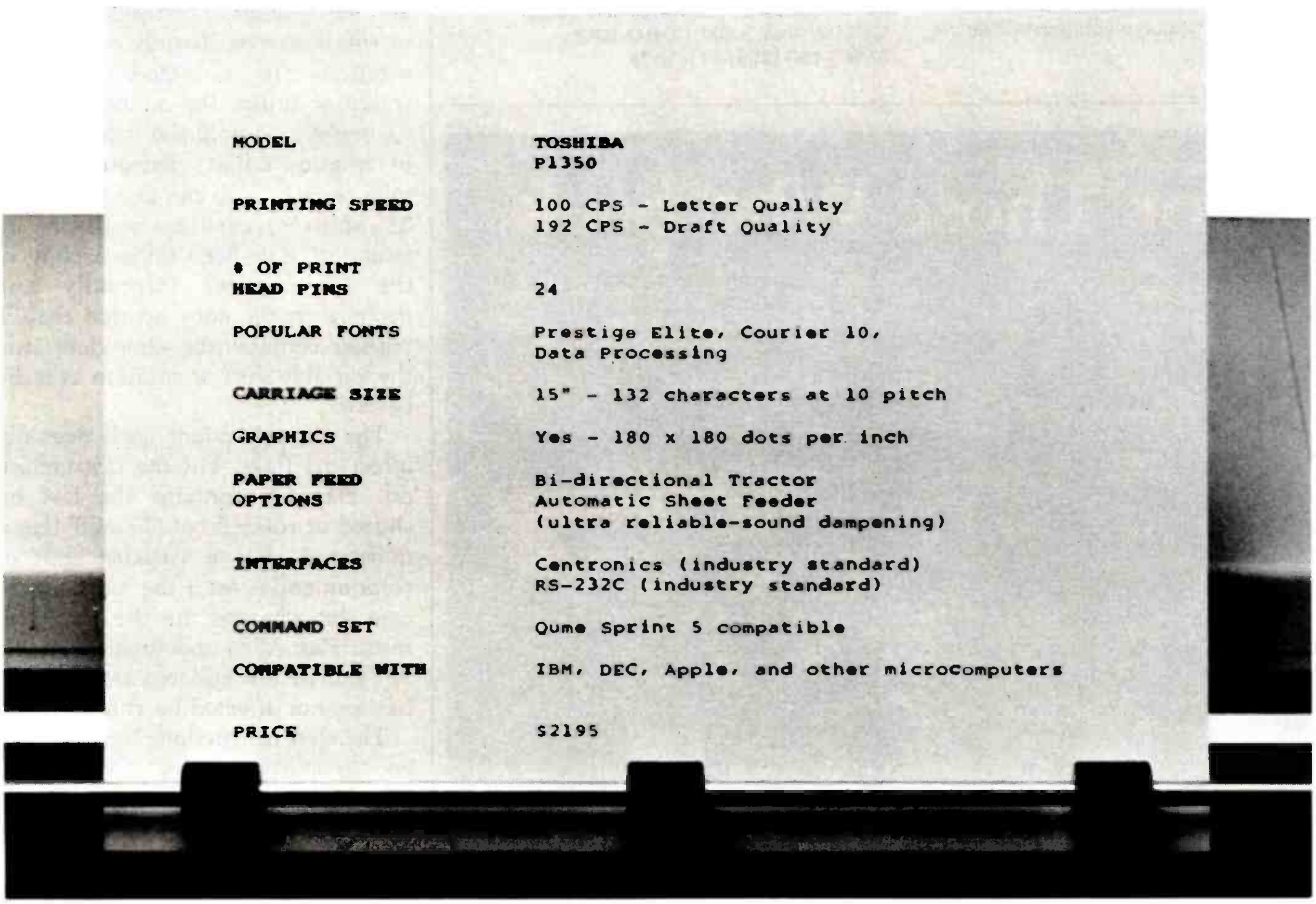

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if you want to test a particular word in memory for a 1 in the most significant bit position, using the BX register to contain the offset of the location, the instruction would look like this:

```
TEST [BX],8000
```

If the most significant bit of the memory location tested is a 1, the Zero flag is cleared. On the other hand, the Zero flag is set if the most significant bit of the location tested is 0. You could then use a conditional jump on the Zero flag to check for a certain bit, or group of bits, being set or cleared. You could program a jump on a zero condition to look for the cleared bit and a jump on a nonzero condition to look for the set bit.

The shift and rotation instructions are shown in figure 7. Each of these instructions has two forms: single-bit and variable-bit. The single-bit shifts or rotations execute only one shift or rotation. The variable-bit shifts or rotations utilize the contents of the CL register to hold the variable shift or rotation count. Because CL is a byte register, you can do as many as 255 shifts or rotations with one instruction. The 8086 takes a copy of the CL register internally and decrements the copy so that the CL register contains the same data after the variable shift or rotation as it did before.

The variable count itself does not affect the flags, but the instructions do. Flag CF contains the last bit shifted or rotated out. The OF flag is undefined after a variable shift or rotation and is set if the most significant bit changes in the single-bit form. Flag AF is undefined; flags PF, SF, and ZF are updated after a shift, but are not affected by rotations.

The shift instructions have an added capability besides manipulating bits as the rotation instructions do. Shift instructions allow a quick way to multiply and divide numbers by powers of 2. For signed operations, you would use the arithmetic shifts; for unsigned operations, the logical shifts. The SHR (shift right) instruction shifts the operand right, filling in

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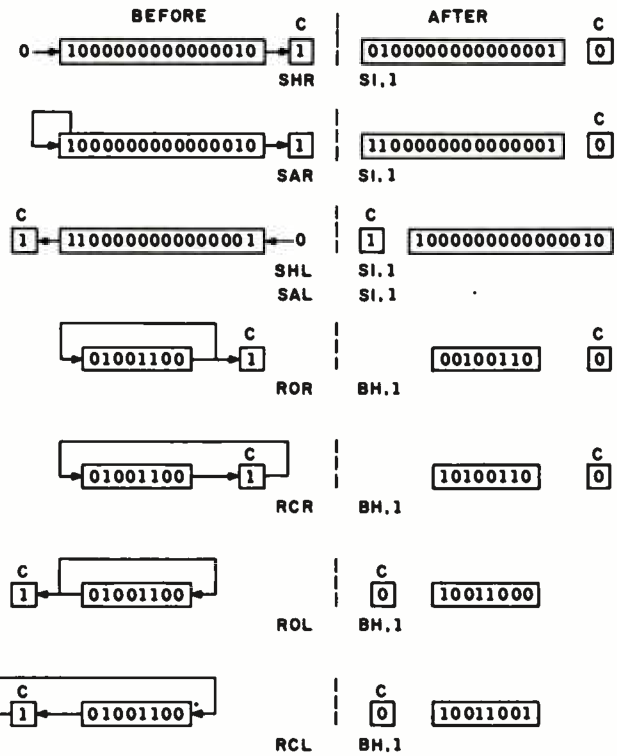

Figure 7: *The shift and rotation instructions work on bytes or words. The two forms of shifts and rotations are single-bit, as shown, and a variable-bit form.*

on the left with 0s to divide unsigned numbers. In contrast, signed numbers need to retain the sign. Therefore, the SAR (shift arithmetic right) instruction shifts in a 1 if the number is negative and a 0 if the number is positive. This instruction performs the same as SHR, but instead of filling in with 0s, the sign bit is used to fill in on the left.

The result from an SAR might not equal the result from an IDIV (integer divide) instruction, though. An IDIV rounds the number toward 0 if it is not evenly divisible. An SAR instruction, on the other hand, rounds a positive number toward 0 and a negative number toward negative. In this case, dividing −5 by 2 with IDIV yields −2; with SAR, it yields −3.

To multiply by 2, both the SAL (shift arithmetic left) and SHL (shift left) arithmetic and logic instructions perform the same operation of shifting left and filling in on the right with 0s. These two mnemonics suit the same instruction. This capability was provided for documentation purposes; it reminds you to check the Overflow flag for a signed operation. For example, if you shift left a byte value of 40 hexadecimal (64 decimal) using SHL/SAL during an unsigned operation, the result (80 hexadecimal) is interpreted as 128 (decimal). But if you treat the number as signed, then the result is interpreted as an incorrect −128 (decimal). You might follow this instruction with a conditional jump on the Overflow flag if it is treated as a signed number.

In this part, I introduced the 8086 data-transfer instructions, arithmetic instructions, and logic instructions. I also described how the 8086 allows memory to be an operand, which makes programs easier to build and more compact.

In part 3, I will finish the instruction set discussion with the jumps, procedures, interrupts, string instructions, and control instructions. ■

About the Author

Stephen Heywood is an instructor with Intel Customer Training and is involved with preparation of the 8086 course. He can be contacted at Intel Corporation, 27 Industrial Ave., Chelmsford, MA 01824.

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Interstellar Drives, Osborne Accessories, DEDICATE/32, and Death Valley

by Jerry Pournelle

Though you won't see this until summer, it is being written in February, an absolutely frantic month at Chaos Manor. First, of course, April 15 is rapidly approaching. Then too, this year, the newest novel by Niven and Pournelle had a March deadline. (Larry and I spent some time in Death Valley, where there are no telephones and no computers except for Adelle, my Otrona Attache, which we used to generate about 50,000 needed words.)

Also, preparations were being made for the West Coast Computer Faire.

The upshot is that although some hardware, and a *ton* of software, have arrived at Chaos Manor, there's not been as much testing of new stuff as I'd like, so this month's column will be a mixed bag.

DBMS Explained

More years ago than I care to remember I worked in the aerospace industry as a systems analyst. That's a strange job title: it means you don't necessarily know anything, but you're supposed to be a troubleshooter, meaning that you're expected to tool up on *any* subject at a moment's notice. I can recall a time when I was an expert on inertial guidance systems, a subject about which I remember nothing at all.

I bring this up because I thought I was going to have to do it again: learn database management systems (DBMS), at least well enough to explain the subject. Fortunately, before I put a lot of serious effort into the work, I discovered David Kruglinski's excellent *Data Base Management Systems*, a new book from Osborne/McGraw-Hill. Reading this book may not make you an expert, but it'll sure teach you a lot about DBMS.

The book has chapters on dBASE II, Condor, MDBS, FMS-80, and a couple of others. It also includes chapters on general aspects of the subject of database management. The book is well done. It begins at a reasonable level—an absolute novice at microcomputing would have to work pretty hard, but anyone moderately familiar with the subject will be okay.

Databases come in three major flavors: hierarchical, network (or CODASYL—from the *CO*nference on *DA*ta *SY*stem *L*anguages, the people who brought you COBOL), and relational. Hierarchical and network databases have inherent structures built into the database itself. Given structured data they can be quite efficient, but there are also limitations inherent in the system design. They tend to be very poor at handling exceptional cases that don't quite fit the predesigned structure.

Relational databases look like tables. There is no implied order to the data. If each row of the table is an employee record and each column is an item in that record (clock number, salary, hours worked last year, length of hair, age at last equinox, etc.), then the records can be ordered according to any column—or not ordered at all.

All this and more is explained in Kruglinski's book, which also goes into what you can do with popular database management system programs, and explains why you might want to pay several thousand dollars for MDBS. (He warns that if you aren't a programmer, the chapter on MDBS may be too technical, and that "While MDBS III may meet your needs, you will require the services of a programmer to evaluate and implement it.")

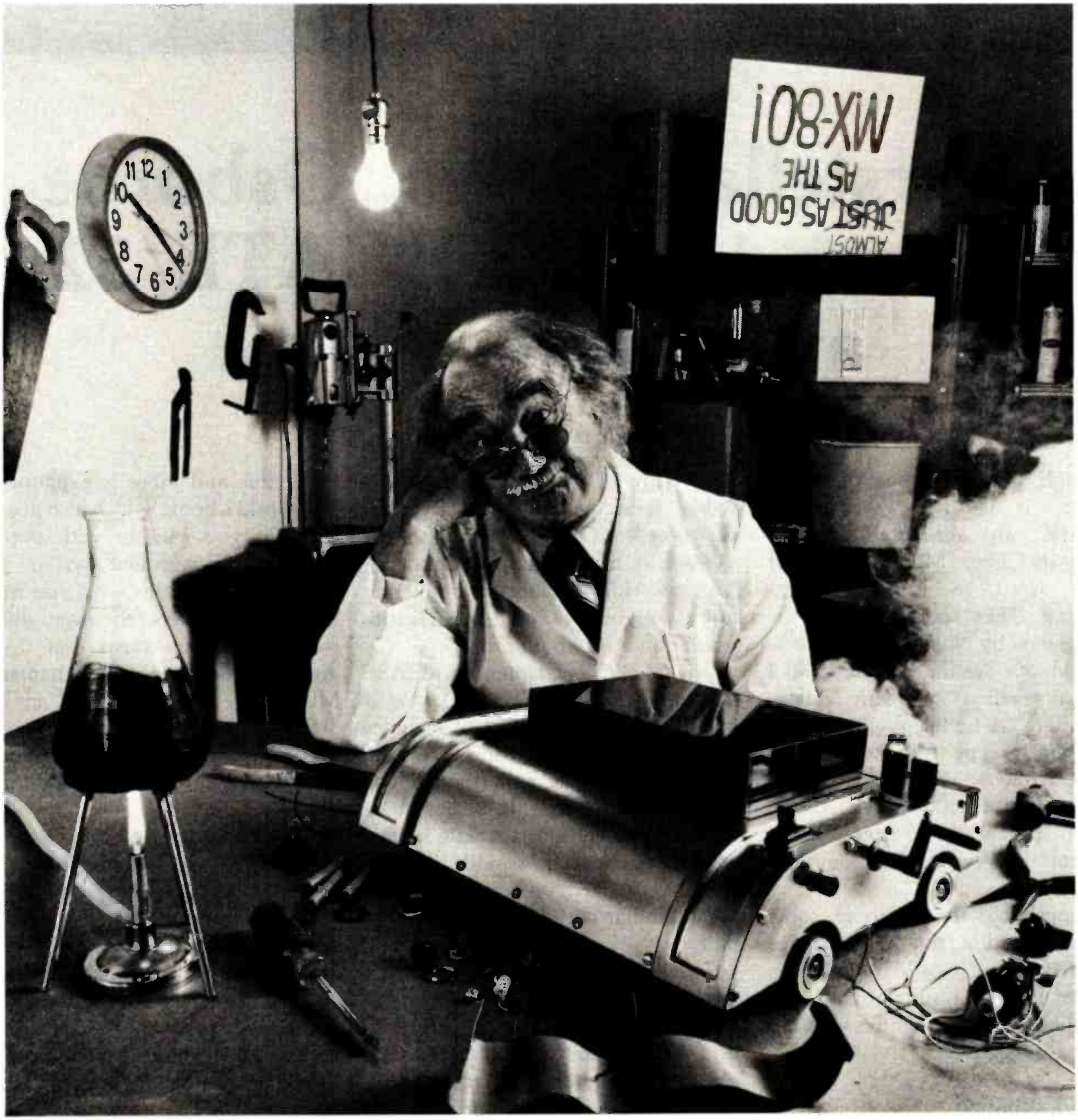
Anyone interested in database management systems should find this book interesting, and those about to buy such programs would be well advised to read the book first. It could save you a lot of money.

In addition, Jeff Cohen sent me a useful discourse on the subject. Alas, he sent it over the net, and it turns out there's at least one other person using the name JEFFC, so I haven't been able to thank him. If anyone who knows JEFFC@E.CC sees this, please convey my thanks and ask him to send me his address.

Interstellar Drive

First it was Warp Drive from Compupro. Then Semidisk. Then M-Drive/H and RAM Disk in the Sage. Now comes Pion's Interstellar Drive. One of these days I'll devise a suitable test for comparing these things.

The Interstellar Drive differs from the others in that it's a separate box with its own power supply. Interstellar Drives are available for the IBM PC, TRS-80, Apple, S-100, STD



For everyone who's tried to top the MX-80, bad news. We just did.

Epson.

The Epson MX-80 is the best-selling dot matrix impact printer in the world. It has been since its introduction. And despite the host of imitators it spawned, no one has been able to top it. Until now.

FX-80: Son of a legend.

The new Epson FX-80 is far more than just doo-dads added on to last year's model. It's the most astonishing collection of features ever assembled in a personal printer.

For starters, it's fast: 160 CPS. And clean. All the print quality Epson is famous for in a tack-sharp 9x9 matrix.

But that hardly scratches the surface.

Create your own alphabet.

With the new FX-80, you aren't limited to ASCII characters. You can create your own. Any character or symbol that can be defined in a 9x11 matrix can be added to the FX-80's already impressive library of type styles and stored in its integral 2K RAM.

So you can create "Sally's Gothic" or "Tom's Roman" just by downloading and modifying standard characters. Or you can create a custom set from scratch. Either way, you can store up to 256 new characters. And if you don't need a new alphabet, the RAM functions as a 2K data input buffer.

Who knows graphics better than Epson?

Nobody, that's who. And if you don't believe it, witness the FX-80.

With a 12K ROM capacity, the FX-80 gives you a few things the others don't. For example, not one, not two, but *seven* different dot addressable graphic modes are program selectable. And can be mixed in the same print line. Everything from 72 DPI (dots-per-inch) Plotter Graphics to the 640 dots per line resolution designed to match the remarkable monitor clarity of the Epson QX-10 personal computer.

And *that* is in addition to an astonishing array of 136 different user-selectable type styles including Proportional, Elite and Italic as well as the more conventional faces you get on other printers.

Hard-to-beat hardware.

The FX-80 has all the hardware features you've come to know and love on the MX Series: logic seeking, bidirectional printing, the by-now-famous disposable printhead, and more.

The FX-80 features an adjustable pin platen or optional friction/tractor feed, so you can use fanfold, roll or sheet paper ... backwards or forwards. The FX-80 even gives you reverse paper feed.

And if you're printing forms, the FX-80 has a feature you're gonna love: a function that allows you to tear off the paper within one inch of the last print position.

Be the first on your block.

We'd be willing to bet that the FX-80 — like the MX-80 — will have its share of imitators. Don't be fooled. To make sure you get the genuine article, rush down to your local computer store right now and let them show you everything the FX-80 can do.

And while you're there ... ask them to show you how it works with our computers.

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bus, and heaven knows what else. The box remains the same in each case; only the interface changes. Thus you can upgrade your system, or change it entirely, and still have the benefits of *RAM disk* or *silicon disk*. (We need a good untrademarked name for this kind of system. I used to call it *pseudo disk*, but that doesn't seem right. Any suggestions?)

Interstellar Drive has battery backup, which means that it's about as safe as disks themselves. Ours came with interfaces for the Apple and the S-100; Alex snarfed it off for Helen, his CCS S-100 machine, where it runs happily. I've been thinking about that battery backup, though, and I may grab it back; that's a pretty attractive feature.

Those who've never tried a pseudo disk generally don't understand what all the excitement is about; but anyone who's used one will find it very hard to do without. These *memory disks* are so fast they're almost instantaneous; faster than even a hard disk, and *much* faster than a floppy. The result is that programs that used to take forever now run at lightning speed.

They make Wordstar pretty endurable; no more waiting while it accesses the disk between parts of a command. Also, you'll save your work much more often, because it takes so little time. With a memory disk I can save this entire article in less time than it took to write this sentence. The problem, of course, is that you haven't really "saved" the work; it's still just in memory.

Adding battery backup could change all that. However, battery backup doesn't *absolutely* prevent loss of data. When you power down, it's possible for the machine to get random instructions, one of which could be to write garbage all over the RAM disk. (This is one reason we're taught to open the drive doors on floppy disks before turning the power on and off.)

There are ways to prevent this. The Compupro System Support board has a power-down detector that could be used to disable the write-to-the-memory-disk capability. I don't know of anyone who's actually done that, so there's always a theoretical possibility that on power-down the RAM disks will contain garbage.

Pion's product has some nifty features. It sports 256K bytes of RAM and includes the interface and software. It also has read and write lights, so that you can tell when *something* is happening. With the other RAM disk systems, you can't be *sure* anything is going on because you can't hear the disks clunk; moving electrons don't make noises.

The power source connects directly to the wall (not through your machine) so that the Pion Interstellar Drive can be left on, with your compilers and whatnot intact, after you've turned your system off. You don't have to initialize each time. The battery backup system works for half an hour; there's provision for more batteries, and it wouldn't really be hard to run it off a car battery.

The Interstellar Drive's major defect is identical to one of its virtues:

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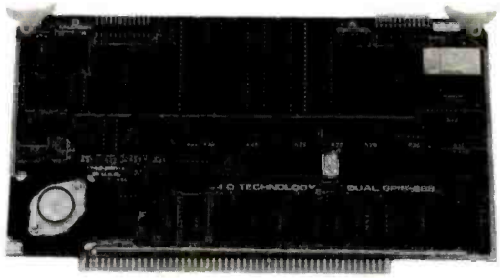

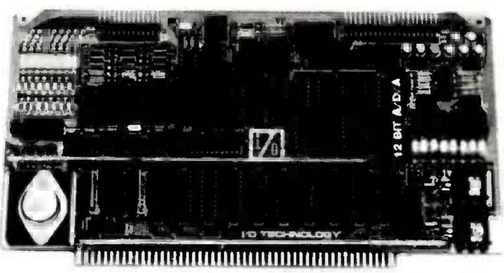

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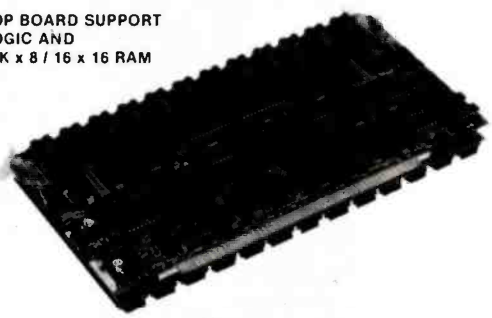

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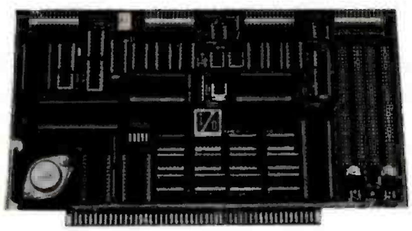

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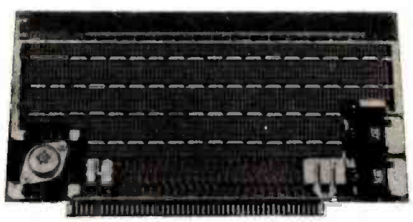

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it's a separate box with a power supply, a cord to the wall, and another cable to your machine; more clutter at the computer table. On the other hand, when you change machines you get to move up the Interstellar Drive as well. If you have several machines and not much money, the Interstellar Drive may be the way to go.

Cache System

Another approach to speeding things up is to use extra memory not as a memory disk but as a *cache*.

Caching is a technique in which frequently used instructions and data are brought up to a more easily accessed area of memory and kept—cached—there until needed. This process is accomplished while the machine is otherwise idle, for example, while waiting for input.

I saw Peter Cheesewright of the British firm Microcosm Research demonstrate his Microcache, and I was impressed. While Cheesewright was in the United States on a tour to demonstrate his product, he worked in a visit to Chaos Manor.

Alas, I've received little information on dealerships. I know that Barry Workman was sufficiently impressed to put Microcache into his inventory. His Lobo, Ralph, came with an extra 64K bytes of memory, and Microcache has no trouble making use of that.

The nice thing about Microcache is that you don't need *much* memory to make it useful. As little as 16K bytes—even as little as 4K—can make dramatic changes in program speeds; whereas memory disk systems need a lot more. Microcache can make use of any bank-switched memory you don't need.

Microcache can help with only a small amount of memory because it stores those items most often called in from the disk. There's a *least-used/first-out* algorithm to decide what's kept and what's replaced in the cache. The result is that the disk directory and bit map are stored and kept, and that speeds up disk operations something wonderful.

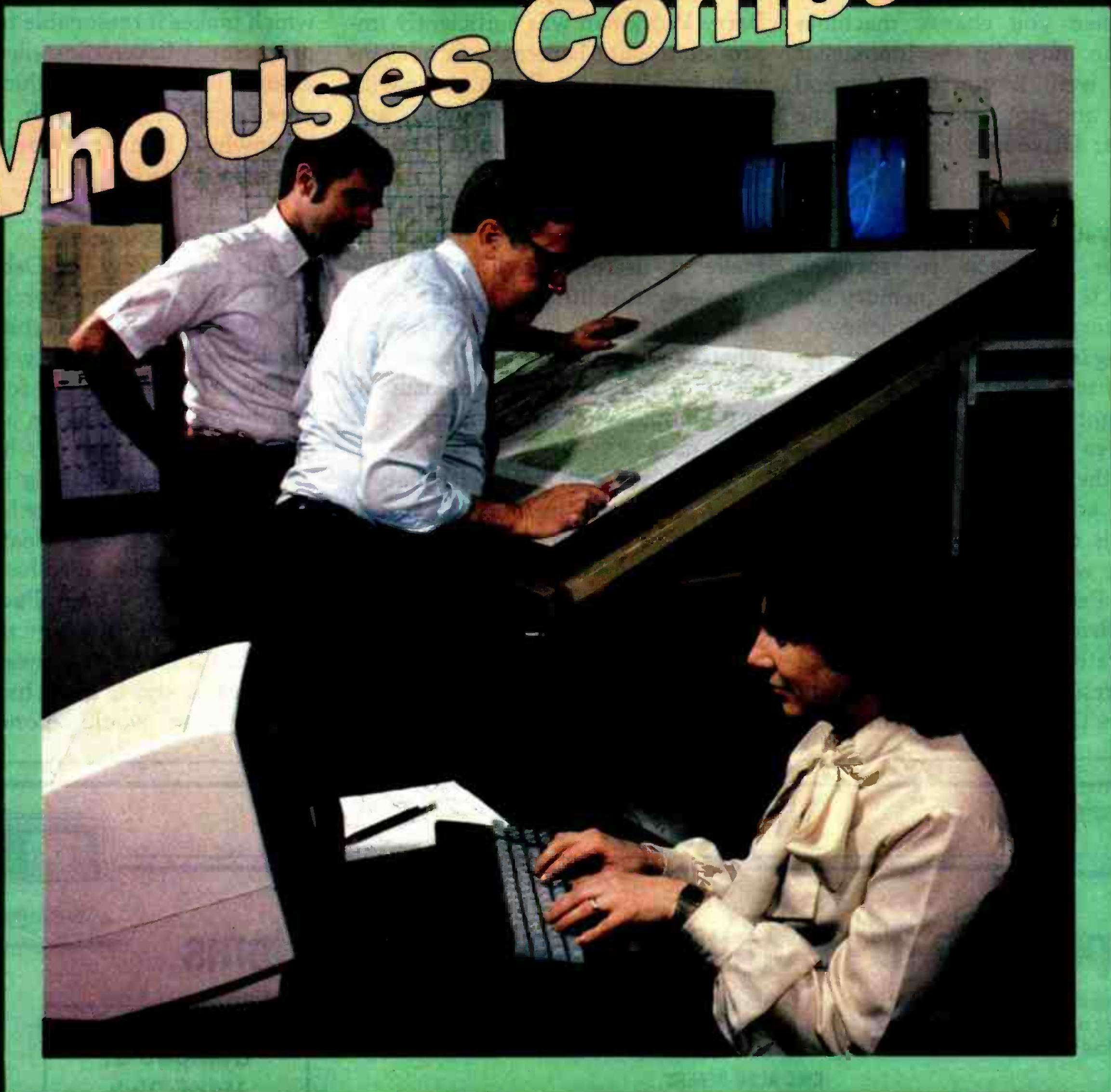
Because things are actually written to the disk as well as cached, battery backup isn't needed with Microcache, which makes it reasonable for a word processor. I haven't installed mine in Zeke II (the writing machine) due to pure sloth; next month for sure! Meanwhile, I know it works because I've seen it working.

Osborne Add-ons

One reason why the Osborne 1 is such a strong competitor is the full line of accessories available. There's the Power-Pac, a battery pack that lets you run the machine for three or four hours (depending on how many disk accesses you do). It's heavy and bulky, and takes too long to charge; but it works, and if you're headed for the Mojave Desert and Death Valley, you'll be darned glad to have it.

Then there's Comm-Pac, a tiny 300-bps acoustic modem that plugs into the Osborne. It comes with full instructions and is quite handy. Better, of course, would be one built in.

Who Uses CompuPro?



BOREXCO finds oil. It sounds simple but Borehole Exploration Corporation relies heavily on a sophisticated system of computer-generated, two- and three-dimensional magnetic models.

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CompuPro's speed, reliability and cost-effectiveness won the respect of BOREXCO's engineering director, Dr. Brad Rehm. "I looked at others and I could not get this level of performance at several times the price," Dr. Rehm said.

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(Please turn the page)

Finally there's my favorite, the Start-Pac. This is a box of flip charts and cassette tapes that explain in detail how to use the Osborne and how to get Wordstar running. The instructions assume very little; we were able to hand the Osborne and the Start-Pac to Boy Scouts and let them work on their own, and soon enough they were writing with Wordstar and copying their disks.

Other companies also make stuff for the Osborne. For instance, the Osborne screen is a bit small for everyday use. Apparently, it's not as bad for me as for some; I hunch down close to it and it's just about right—seen through the lower half of my bifocals. Some, though, find it maddening.

One remedy is the Osborne large screen. That works fine, but it's both expensive and bulky. There are considerably better and smaller monitors, like the Zenith, but the Osborne's video format is such that you can't feed it to a normal monitor.

Comes now: JMM Enterprises with Ex-Mon. Ex-Mon plugs into the Osborne and converts the video output to something displayable by a normal monitor. It does it without shutting off the little 5-inch screen, too. Recommended.

It's Mysterious All Right

I see that Tandy has finally authorized a book, *TRSDOS 2.3 Decoded & Other Mysteries*, explaining TRSDOS for the Model I. It's published by IJG, which originally published the first—very much *un*-authorized—sensible book on the TRS-80 operating system, *TRS-80 Disk & Other Mysteries*. The publisher tells us that Tandy "authorized" the book but doesn't say whether Fort Worth gets part of the $29.95 list price.

The publisher claims that this book 'Marks a major breakthrough in the exchange of information between users and the manufacturer." The breakthrough comes now that the TRS-80 Model I is no longer manufactured and Tandy is phasing out its support of Model I TRSDOS. Some breakthrough.

I'm a little bitter about my experiences with Tandy. I had genuinely thought that the Model I was the machine of the future: an inexpensive home computer that could be expanded by stages until it would do professional work. Of course it was never that. First, Tandy tried to fence in Model I users through that goofy operating system, and then it wouldn't let Radio Shack stores sell non-Tandy software.

Details of TRSDOS were very hard to come by. There sprang up substitutes like NEWDOS by Apparat, which published a "zap" a week (fixes to TRSDOS), LDOS, and DOSPLUS. Eventually, the hobbyists figured out ways to make TRSDOS work (more or less); by then, though, the Model I was on its way out. It had never been all that well designed, and when sales took off much faster than anticipated, the quality control system couldn't cope.

It's mysterious, but I'm just not as impressed as I could be by this major information exchange breakthrough.

Free Software

The CP/M User's Group supplies about a hundred disks of public-domain software. A catalog is available for $10 ($15 overseas). The price is $12 for a single-sided single-density 8-inch disk (240K bytes) pretty well packed with programs.

What you get is a mixed bag. Some of the disks have terrific stuff. Others have boring games in BASIC. One has an air search and rescue simulation/game that might be interesting. Another has a pretty good mailing list program. Others have Pascal/Z programs, some of which accomplish feats that no human has ever wanted accomplished. And again, scattered among all this will be real gems, worth more than a lot of programs sold for stiff prices. (Incidentally, probably 50 percent of the really good programs were written by Ward Christensen, a public benefactor.)

Every time I mention the CP/M User's Group in this column two things happen: one, the address is given in the Items Reviewed box that always accompanies the column, and two, up to a dozen people write and ask me for the address. That used to

Can you tell the IBM® from the Transtar 130?

A

Letter quality standard of the industry

5x magnification

B

Letter quality standard of the industry

5x magnification

One of these two print samples was generated by an **IBM Selectric II**: the letter quality standard of the industry.

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And print quality is just the beginning! The new Transtar 130 daisy wheel printer is also plug-and-go compatible with the best-selling word processing packages! It features bidirectional printing, superscript, subscript, underlining and a true boldface. Retail price? **Only $895.**

Quietly producing copy at 18 cps Shannon text speed, the Transtar 130 also features a unique autoload button to make printing on letterheads a breeze! Three new daisy wheels have just been made available for the 130 from your dealer: letter gothic (shown), script, and a 15-pitch "gothic mini"—perfect for printing spreadsheets to fit on one page!

Offering an end-user warranty period of a full six months, the Transtar 130 is an extraordinarily reliable machine. Its minimal failure rate runs less than 1%, but if your 130 should ever need repair, a nationwide network of authorized Transtar service centers stands ready.

Have you decided yet whose type is whose? If you picked A...You picked Transtar. The new standard for letter quality printing.

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bother me more than it does now. Anyway, the address of the CPMUG is

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1651 Third Ave.
New York, NY 10028

Don't try to telephone them. There's no one to take your call. You *can* connect to a computerized bulletin board system (CBBS) operated by Christensen by calling (312) 849-1132. This is a single-user system, so don't be a hog. I haven't used it myself, so I can't supply details. The CP/M User's Group disk catalogs are filed on this CBBS.

Ward Christensen is the author of MODEM7, probably the most popular microcomputer communications program in existence. MODEM7 is available from the CP/M User's Group. It isn't particularly easy to use or install, but given familiarity with your system and assembly-language programming it can be done.

Once armed with MODEM7, you can go hunting for free software. Plenty of it is available, both in the public domain and an increasingly popular variant that has no name, but works thus: "If you like this, send me (the author) some money. I prefer cash."

Linking Up

One perennial problem is how to get .COM files from one machine to another. With any luck, you can transfer them on floppy disks, which are quick and efficient—after all, that's why floppies were invented in the first place. Unfortunately, all too many machines can't read each other's disks. In those cases you must transfer the files "port to port."

Even when both machines have apparently identical RS-232C serial I/O (input/output) ports, the problem is nontrivial. Not all RS-232C ports are the same. When ports are the same, data rates can differ. In your CBIOS (customized basic input/output system), there's special code to tell your machine how to send information to, and get it from, those ports; and the methods used are not always obvious. A full discussion of the hardware options would run longer than this entire column.

Once you've got the hardware hookup taken care of, it's a fairly simple matter to send short—20K bytes and under—*text* files from one machine to another using PIP (although sometimes, for no reason Tony Pietsch or I can predict, even short text files come across garbled). Longer files, and binary files (such as COMmand files, like BASIC or a text editor), are a more difficult matter. If you have MODEM7 up and running on *both* the sending and the receiving machine, there's no problem; but suppose you don't? How can you get MODEM7 over to the receiving machine in the first place?

There are other communication programs (e.g., SOFTCOM), but many of them will *not* work with some advanced microcomputers because they were written some years ago.

Text continued on page 339


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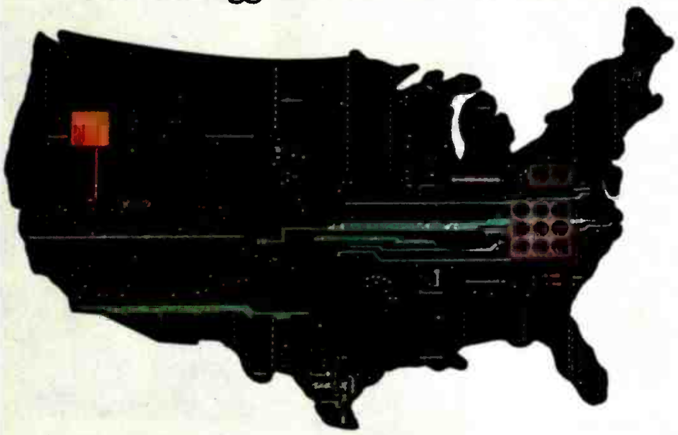

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Tony decided to do something about this problem. He wrote a program called SEND-HEX, which converts files into Intel hexadecimal format and then transfers them. Once received, the files can be converted back to their original format, whether text, .COM, .REL, or whatever.

SEND-HEX works like a charm. We used it to transfer WRITE (our snazzy text editor) and XD (an enhanced DIR command) over to Adelle, my Otrona Attache portable computer. Then we used SEND-HEX to transfer files from the Otrona to the Kaypro. Indeed, whenever we get a new CP/M machine, or there's any kind of file-transfer problem, we haul out SEND-HEX.

Barry Workman wanted to publish the program, but Tony's documentation, though good enough to let me use his program, said far too little about file transfers in general and had a number of "you know what I mean" loose ends.

I had made some notes on file transfer for my own reference; by judicious application of slivovitz, Barry talked me into polishing up those notes as the documentation for SEND-HEX, which he's marketing under the name The Transporter.

I decided to write everything I could think of about file transfer: hardware, software; the difference between physical and logical devices; data terminal equipment and data communications equipment; RS-232C ports, the kinds of RS-232C cables; and more. The theory was that I'd make it do double duty by putting it into this column.

Hah. The result was more than 8000 words. Linking computer systems isn't really all that complicated, but there's just a lot of detailed stuff you must be familiar with. I ended up going to about nine books, each of which has *some* of the information needed. As Alex puts it, we scoured the earth.

There's no chance I'm going to get all that in the column, and I find nothing I can cut and still make it complete and self-contained. Barry is including it as part of The Transporter package. I'm *not* getting royalties on it.

Bits, Bytes, and Buzzwords

Not long ago, Federal Express delivered a thick sheaf of galley proofs. It turned out to be *Bits, Bytes, and Buzzwords: Understanding Small Business Computers* by Mark Garetz. Mark is president of the CompuPro Division of Godbout Electronics, and he's written one heck of a book. It's the kind of introduction to small computers that this field has always needed, and which, I confess, I was tempted to write myself.

I won't have to just yet. Garetz's book isn't as good on software as I'd like to see, but it's as good an intro to hardware as I've come across.

That's not just my opinion. My son Alex is a senior in computer science. Jennifer, his young lady friend, weary of innumerable conversations of which she understood not a word, decided to learn something of computers in self-defense.

Tonight, while browsing through Garetz's book, Jennifer learned that the goofy numbers like 6502 refer to computer chips.

Included are chapters on computer systems (CPU, memory, input/output, etc.); peripherals (terminals, disk drives, and printers); and software. The latter part of the book isn't quite as good as the rest, but it does give a good discussion of what an operating system is and why you need one.

There's a good discussion of 8-bit versus 16-bit machines, and which are useful for what. Not surprisingly, Garetz recommends microcomputers using the S-100 bus—a conclusion I completely agree with.

Understand, the book is introductory. Hackers with several years' experience won't find anything new. Beginners, though, should find it a godsend. Highly recommended. Jennifer was impressed.

Drop Dead, Twice

Many a year ago, I wrote a science column for the late, lamented *Galaxy* science-fiction magazine. For one issue, I had to calculate spaceship orbits with a slide rule and log tables, and I almost went out of my mind. I desperately needed a scientific digital calculator. Alas, at the time there existed Hewlett-Packard scientific calculators, but they were priced far out of my reach.

Then came the Texas Instruments TI-50, which cost about $150, less than half what HP wanted for its machine. The TI-50 had logs, and trig, and fractional exponents—everything I needed. I hung my Pickett Log-log Decitrig slide rule on the wall, gulped hard, and wrote a check. I've never regretted it, and the Pickett is still on the wall.

Thus, I've always had a soft spot in my heart for TI. When my mad friend got me involved with small computers, both of us thought our second machine would probably come from Texas Instruments. We were sure that, as with scientific calculators, TI would lay back until it could deliver a machine that did more for half the cost.

We expected that right up to the time when TI came out with its personal computer, the TI-99/4. Then we knew better. Not only was the TI-99/4 slow, but you couldn't get into it. TI published almost nothing about its innards, nor was there the kind of software, such as assembler and debugger, that encouraged tinkering.

TI's message was loud and clear: "Drop dead, hobbyists!"

Last year at the West Coast Computer Faire, I talked to a number of TI people and was convinced that TI had reformed—that it would encourage outsiders to write software for its machines.

Today I learned better. According to the *Wall Street Journal*, TI is using ROM-based hardware to ensure that unlicensed software cartridges won't work on the TI-99/4A. Anyone who wants to write programs for the TI-99/4A must sell all rights to TI, who will be the sole software supplier. It will, it says, pay royalties to the authors.

I haven't seen the contracts TI offers, but if they at all resemble those IBM tried to foist off on authors, it shouldn't have many takers. TI is altering its computers so that only software making use of a GROM (graphics read-only memory) can work in the 99/4A. TI owns exclusive rights to the GROM, and it won't license it to anyone else. That way, TI keeps a monopoly on software that runs in its computers.

A number of software designers have decided that they'd rather work with other machines; and according to the *Journal*, Charles LaFara, president of the TI Users' Group, says, "TI hasn't given us enough quality software itself, and now it is stifling the efforts of others."

I've always thought the TI machine had more potential than it ever showed. When TI told me that it was going to encourage hobbyists to write software for its machines, I predicted that TI was still a company to watch. Hobbyists are an insignificant part of the market, but having them working on software is like having a large unpaid R&D department—it takes only one Visicalc to make a computer successful.

Now, TI once again tells the hobbyists to drop dead. That may be good strategy, but I wouldn't bet on it.

Using the Otrona

Because Larry Niven and I hadn't got as much done on our *Footfall* book as we should have, last week we piled our stuff in my International Scout and took off for the desert. We ended up in Death Valley.

We bounced over many an unpaved mountain and desert road, crossed the Amargosa River, and did a bit of off-roading on the side. Each night we checked into a motel, and the first thing we did was set up Adelle.

I'm pleased to report that there were no glitches whatever. Adelle performed flawlessly.

Larry found the small screen annoying. Because he had to take his glasses off and get very close to read the screen, he was never happy with it. No matter. The Otrona has a built-in video-output jack, and next time I travel with Larry I'll take a good monitor.

Meanwhile, Adelle, protected only by a large padded bag, jounced around in the back of my truck, en-

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Circle 286 on inquiry card.

during cold and humid weather as well as excessive jolt and vibration; and she still runs perfectly. My earlier conviction that 8-inch disks are more reliable than 5¼-inch disks is fast being overcome by experience. What could we do to those disk drives that we haven't done?

Idiot Proofing

When Tony Pietsch was over to install Zeke II, he asked for a big cardboard box. I went up to the attic and fished one out. It turned out that he wanted to make a cardboard modification for the Compupro "box."

(Incidentally, we need a good term for the box that contains a microcomputer's bus and power supply. It has become traditional to call it "the mainframe," which seems a bit silly because it's the name we also give to computers that are much larger than minicomputers. "Box," however, seems irreverent. Ah well.)

Anyway, the Compupro box (case? enclosure?) has the bus along one side, then a barrier strip, and the power supply along the other side. Many other computers are built along more or less the same lines.

There's considerable juice in a computer power supply. It is *not* a good place to put your fingers. It is also not a good place to drop tools, unless you like sparks.

There's another potential problem when you open a computer box (at least for S-100 bus systems)—airflow. The Compupro is typical enough: it has a fan that blows over the power supply. The barrier between power supply and the card cage is perforated, and the normal air path is along the power supply elements, through the holes in the barrier, and thence across the components. If, however, the lid is taken off the box, the air is not confined and instead of taking a circuitous route out to the boards, simply goes up, not cooling the boards at all. This can cause concern on hot days.

The problems, then, are exposed source of heat and excessive opportunity to contact unhealthy voltages. The remedy is simplicity itself.

First cut a length of cardboard sized to fit the area over the power supply—that portion of the system to the right of the barrier strip. Now put the cardboard over the system. If you've measured just right, it will stay there. (You may have to cut out a slot for the top of the fan.)

The result is what Tony calls idiot proofing: the cardboard keeps dropped screws and tools, and your fingers, out of the power supply; it also forces the air to circulate properly even with the case opened, resulting in cooler and thus more reliable components.

I expect this kind of tip is more in Ciarcia's line than mine, but I have to woo his readers somehow . . .

Trapdoors

I have a program that would have excited my mad friend no end.

I've never known MacLean's exact connection with the U.S. government, but he does seem to have done some intelligence work. One thing that very much interested him was ciphers and codes. He obviously knew a lot about them.

I say obviously, because he was fond of disassembling programs. Disassembly is the process of taking object code and turning it into source code. Given the source code, you can modify the program. Programmers go to great lengths to protect their source code. In one case, all the English-language text messages in the program had been encrypted in an attempt to ward off disassemblers.

That might have worked for most, but it hardly slowed my mad friend at all. It took him about an hour to figure out what the programmer had done, and another two hours to solve the cipher.

He was always interested in anything published about codes and ciphers. I particularly remember his excitement when the science magazines began publishing articles about *public key cryptography* systems (also known as *trapdoor functions*).

Probably the simplest way to describe what public key systems do is to quote from the manual of a software package called DEDICATE/32:

Continued on page 347

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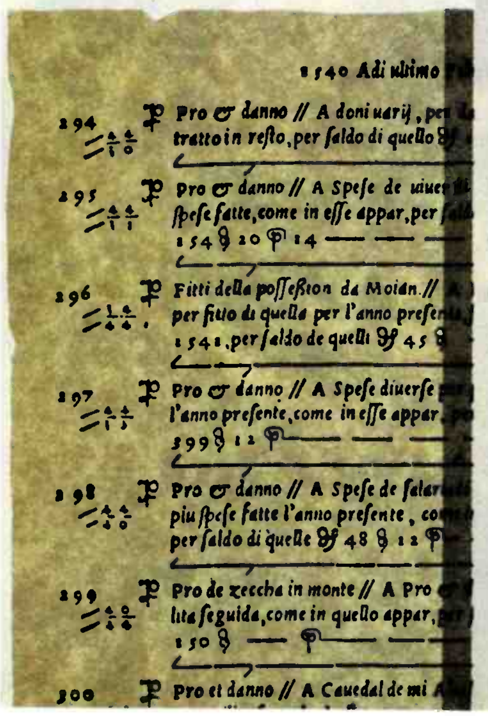
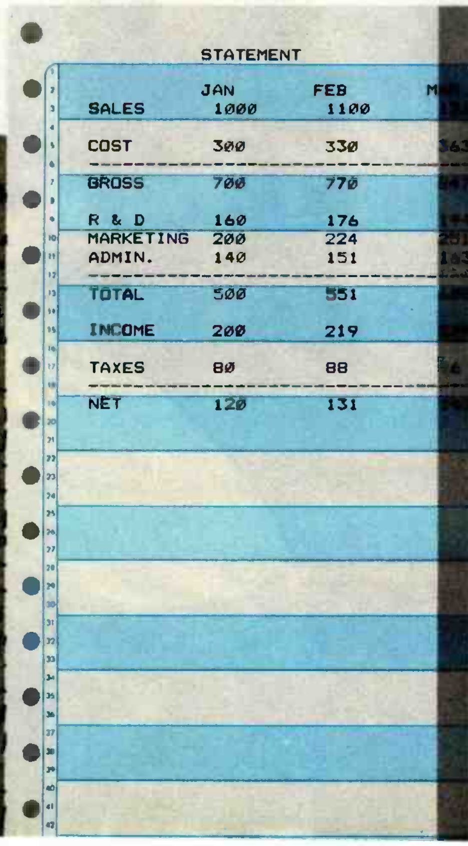
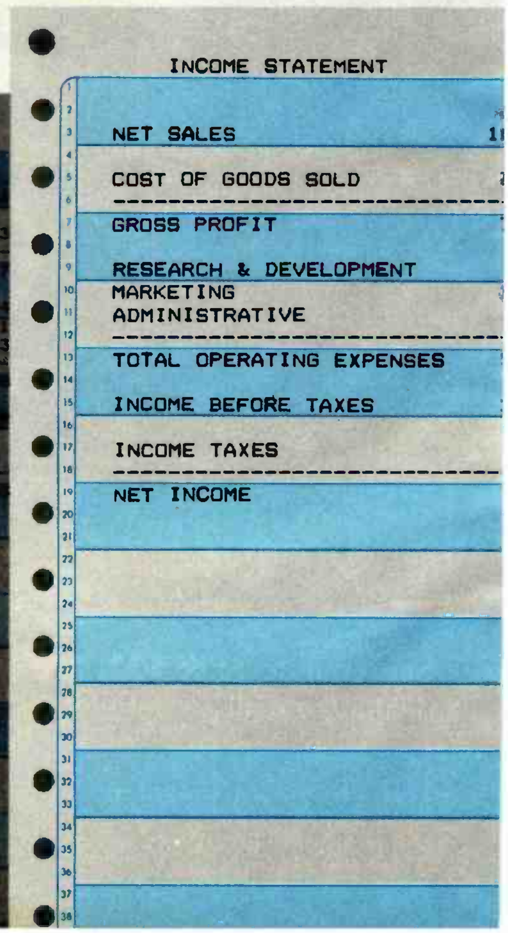
1534



1979



1981



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Today's Date	4/15/83	Deduction Percentages	
Payroll Start Date	4/ 1/83	Fica	6.700%
Days this period	15	SDI	8%
Recalculate YTD Y/N ?	N		

User-set decimal places.

Emp#	Employee name	Status	Gross Salary	Total Deduct	Net Pay	YTD Gross
34	Adams	M	$1,100.00	($82.50)	$1,017.50	$6,200.00
49	Beckette	S	$750.00	($56.25)	$693.75	$5,250.00
84	Johnson	S	$850.00	($63.75)	$786.25	$5,950.00
92	Jones	M	$900.00	($67.50)	$832.50	$6,300.00
12	Samson	S	$560.00	($42.00)	$518.00	$3,920.00
19	Santos	M	$650.00	($48.75)	$601.25	$4,550.00
45	Smith	S	$700.00	($52.50)	$647.50	$4,900.00

Total # employees 7

Floating $ signs.

Embedded commas.

Total Gross Salaries (100's)	$55.1
Total Deductions (100's)	$-4.1
Total Net Pay (100's)	$51.0

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Before public key cryptography was invented all crypto systems were of the "single key" type. A key was chosen to encode a message. The sender of the message had to communicate that key to the receiver of the message so that the receiver could decode the message. This meant that the key had to be transmitted over a secure channel, or that the two parties communicating had to make prior arrangements about the key.

Public key cryptography can be called two key cryptography. The idea is that two different key pairs are generated by each user of a system. Out of each pair one key is selected as the public key (it could be either one) and the other key is the secret key.

The public key is indeed published. *Anyone* can use it. I have included my public key in this article (see listing 1). Anyone wishing to send me a secure message can, supposedly, use this published key to encode the message, after which the message can be sent in a letter, broadcast, sent by signal flags, or otherwise published without danger of compromise.

The mathematical underpinnings to this kind of encryption are known as trapdoor functions. They're called that because the keys act like a trapdoor: you can encode the message with the public key, but once you've done so, you cannot *decode* the message. Only the possessor of the secret key can decode.

It works the other way, too: you can encode a message using your secret key. Now anyone can decode it, using your public key; but the fact that it decodes into a message is proof that the possessor of the secret key actually sent it. Thus messages can be sent with a very secure signature.

Now we have what seems to be a public key cryptography system. I say "seems to be," not because I have any reason whatever to doubt the claims of Charlie Merrit and the other authors of DEDICATE/32, but because I have no means of evaluating the truth of their claims.

Certainly DEDICATE/32 "works" in the sense that it apparently does what it is supposed to do. It generates both public and secret keys; and when you apply the keys, encrypted messages result. When you use the decode program, the original message comes back completely unaltered; even the formfeeds and control characters are intact.

DEDICATE/32 has splendid documentation. That, incidentally, wasn't always true: the preliminary document told me more about the theory of public key encryption (and might profitably be included as an appendix to the new manual), but it was very confusing on how to use the system.

The new manual has only about 500 words in it. It tells you exactly what the program does and how to accomplish it. A 12-year-old can use this program. I know, because I had one of the Boy Scouts try it without help from me.

The messages that the program gives you are so clear and complete that it must have taken me about five seconds to get past the only minor omission in the manual. Hear and believe: this program is easy to use.

DEDICATE/32 took about 44 seconds to encode a 37-word message. The encoded message (shown in listing 2) takes 2K bytes of file space. It took 40 seconds to decode.

I then used the program to encode an 8K-byte text file (my vita if you must know). There are 1028 words in the file; it took 1 minute and 4 seconds to encode, and the resulting encrypted file was 17K bytes long. Decoding *that* took 1 minute and 10 seconds. In both cases, the decoded files are byte-by-byte identical with the original.

In other words, this program works *splendidly*. MacLean had thought that any such system would be quite slow; I am very pleasantly surprised. Indeed, that's my only grounds for misgivings: it just seems so darned easy and simple! I thought "unbreakable codes" would have to be a hell of a lot more complicated.

I am *not* a cryptography expert. Thus my evaluation is *necessarily* incomplete because I can't tell you whether DEDICATE/32 actually generates an "unbreakable" code.

I am doing two things about that. First, I'm publishing a message encrypted with my public key (see listing 2), and I'm providing the public key. There will be a reward —value not to exceed the price of a

Listing 1: *My public key as generated by DEDICATE/32.*

```
PKSKEY(tm)

032

AA JC NE FJ EP HN EH BG BF

FB DB DL DE MH PB EO MH BD

PF BB MI LO OM OG IB DK BP

JD LF FG ME EK OF KC IB AJ

AA PF GP KD CC KF MG GG AJ

MP FL MH GJ JE BL LA MP AO

KL JD AB AD LH KL PN LA BP

MN JE MB DH HF HD PG EH BH
```

Listing 2: *Secret message (37 words) encrypted using my public key.*

```
THIS IS AN ENCODED FILE

FORMAT                 PKS032AXPAND00001

ORIGINAL FILE NAME     SECMSG2.TXT


AAAJOMIMCIIAFIAHKGIHABOFJFODLDALLFGPLIJIGHHMOLLHFLHIFINONCAGHHPG

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

LPLLDNKCPCOHJOKCOLFMCLNCPCIJIIKHFCHNJOODIKNPIODPJFJJHMJNGCOBBDLH

IBHAMHIEEMMJGCLPPDBPAEHCIEJBLMHLFNLAOGIOCPMDOBCMKNHKJIGJJAEBOMIM

CECGMOJGJKBMOCHMOEGKKMCCLHGGCOGAOPAMCDDAEKHOPIEFGCOGAGJLJGIHKOBL

NJLOOEFJMHCPEKJICFAPBEMENCHOFEFIPAGDNEECPIAJOEBHDOCCNHGIEHKOOFBE

GMFMDIDDKKNAEKNOJBGKNHAABAALPOOIPOBMPNANMPAFKACDGDEIJJKGNEJHEDKE

NOPAKDKHBOMNFFOMNDNLDNCMLPEJNCMECCICCJAAEHCDHHKCKADKOLIFCFIBDFLN

JJGMCFNHJCPEDKBGIJNPOHAHLIKENPGNCGFJDOIOOOFMDINBNOLBFMALNKOGBGNI

HALBFGCONKMFMHNQEBJPNFNKDMHHLFFAHMOONIPPBFLNEKDOFBJNOMFHEMFDFCDO
```

good dinner, the next time I'm in the winner's city (or when the winner comes to a computer show I'm at)—for the first person to send me the plaintext of the message.

Second, I'm putting both the public key and a longer message (my vita) onto a net that includes my friends Marvin Minsky, John McCarthy, and a whole host of top graduate students in computer science. If anyone can break this, they can; and if anyone does, I'll let you know what resources were required to do it! More than that I can't do.

Understand: I have no reason whatever to suspect that DEDICATE/32 does not do precisely what it says it will do, and I have a number of reasons, including my general impressions of Charlie Merrit, whom I met at Comdex, to believe that it *does* work. It's just that for once I'm over my head. I guess it won't be the last time I wish I had MacLean's advice, but he's on another assignment.

Things My Postman Brings Me

I have an unusual poison-pen letter: it is signed, but there's no return address. Usually there's no name.

Apparently my columns *really* vex Paul Cystime of Colorado Springs. He tells me that he generally doesn't "have the time to respond to authors (and their inevitable 'articles')," and confesses that he has nightmares about this column, greatly fearing that he "will be forced to read all your whinning [sic] articles." He then asks advice.

"Me and another feller," he says, "want to publish a book containing the usual drivel. . . . Can we get paid for it?" The letter is printed in dot matrix with a well-used ribbon; but Mr. Cystime found it necessary to add in neat handwriting that he has been wanting to get this off his chest for *months*.

I really hate to think of someone being "forced to read" my columns, only to be upset by them.

I fear I can't help him get published. *Writer's Digest* contains articles that might be of use.

As to his other difficulties: my partner Larry Niven sometimes gets letters like this. Larry's reply is, "Reading Niven is a privilege, not a right. Therefore I have instructed my publishers not to allow you to buy any of my books ever again. Every bookstore in the country will be notified."

I suppose something of the sort should be arranged here. Perhaps the subscription people could scissor my article out of Mr. Cystime's copy. I really hate to think of him being "forced to read" my columns when they so obviously upset him . . .

Fortunately, most of my mail is far more interesting (at least to me). For all those who sent Get Well Soon cards to Ezekial, and condolence cards to me in commemoration of his demise, my sincere thanks. Zeke has, alas, been dismembered; but crucial portions have been combined with MacLean's Alice to become the new computer for the Los Angeles Science Fantasy Society Inc., so that the story has an almost happy ending.

Thomas Goodey writes from Japan: "You blew your Otrona using a hair dryer converter to go from 225 to 110. I did exactly the same thing to my Osborne in Thailand. Fortunately it was just the fuse in the power supply.

"I expect it was one of those very light converters that don't contain a transformer. They perform a peculiar chopping action on the 250 volts AC to produce a wave that acts like 110 for some devices, but isn't reliable for delicate electronics . . ."

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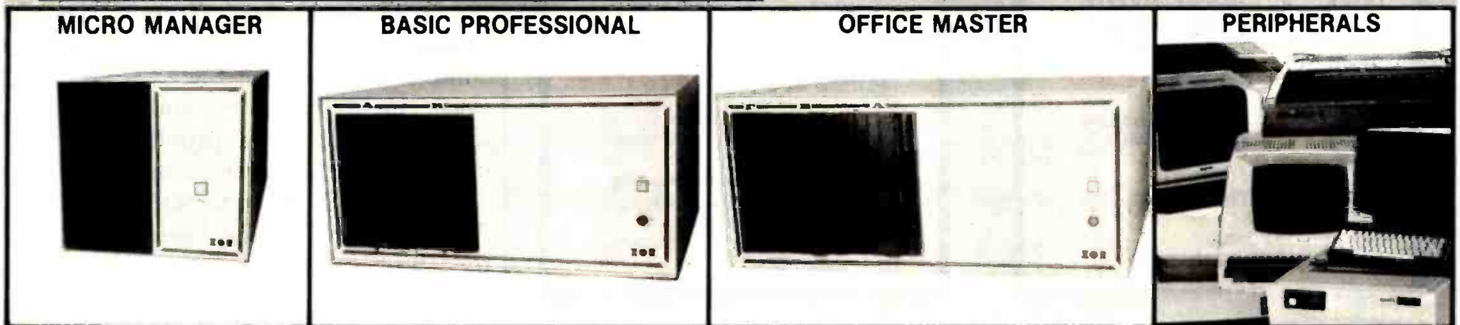
- Q: What free software will I get with my system?
- Q: What will "M" Disk do for me?
- Q: What disk formats is my system compatible with?
- Q: How can I expand or upgrade my system?
- Q: What is the difference between your cartridge disk and a conventional hard disk?



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See Page 545 for Additional Product Information

Circle 303 on inquiry card.

Circle 301 on inquiry card.

Circle 35 on inquiry card.

Circle 310 on inquiry card.

Circle 351 on inquiry card.

Circle 276 on inquiry card.

He is right of course. Be warned: the usual traveler's power converter will *not* work with your portable computer. If you don't know quite a lot about power conversion, get expert advice before going overseas.

My Otrona has on-board conversion for almost any conceivable power supply; my problem was that in one Roman pensione the wall socket was very nonstandard, and the only thing I had that would plug into it was that wretched converter. It's a mistake I won't make again, and one very much worth avoiding.

D. L. Bailey of Mitre Corporation informs me of a book by J. G. P. Barnes, entitled *Programming in Ada*. According to Mr. Bailey it is better organized and more readable than the I. Pyle book (*The Ada Programming Language*) I've previously recommended.

I don't yet have a copy, but Mr. Bailey's letter is pretty convincing.

On the subject of Ada, Marin David Condic of Chicago asks if there's an Ada compiler for microcomputers that can make use of generic procedures and packages. The Janus compiler from R&R Software won't compile his programs because he makes extensive use of that feature. He asks, "Are you aware of *any* Ada compiler, for *any* small machine, that will handle generics?"

I fear I don't know of any now; I invite reader comments.

Fred Willink of San Jose, California, comments: "Your column in the January issue was of interest because you mentioned that Target Plannercalc and the CCS computers won't work together. I had the same problem.

"Both Target Plannercalc and the CCS BIOS use the same reserved but unused area of CP/M page zero from 50 to 5B hexadecimal. CCS uses the area for storage of SECTOR ID starting at 4E hexadecimal. Target Plannercalc's use of this area is unknown. Since source code for the CCS BIOS (basic input/output system for the CCS computer) is provided for customizing, this is the easiest fix.

"The label IDSV in the DEBLOCK PARAMETERS at the beginning of the CBIOS can be deleted and moved

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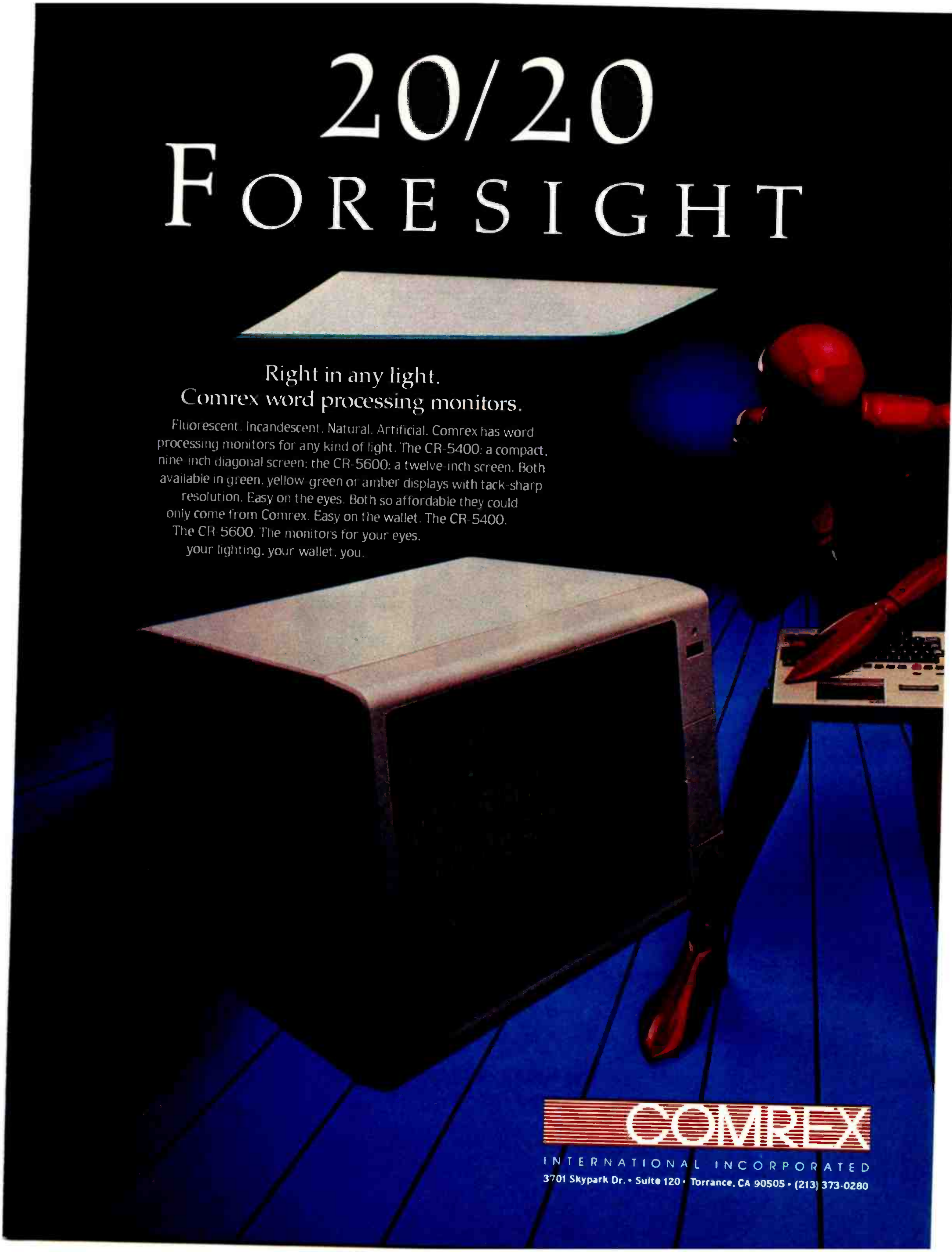
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Books Reviewed

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Understanding Small Business Computers $7.95
Mark Garetz. Beaverton, OR: Dilithium Press, 1983, 110 pages
(800) 547-1842
(503) 646-2713

Data Base Management Systems $16.95
David Kruglinski. Berkeley, CA: Osborne/McGraw-Hill, 1983, 260 pages
(800) 227-2895
(415) 548-2805

TRSDOS 2.3 Decoded & Other Mysteries $29.95
James Farvour. Upland, CA: IJG Inc., 1983, 304 pages
(714) 946-5805

to the BEGDAT area at the end, as follows. First find

```
;DEBLOCK PARAMETERS
;
WRALL:      EQU  0
—           —    —
```

and delete

```
IDSV:       EQU 4EH   ;Sector ID
                       Save area
```

Then find

```
BEGDAT      EQU $
```

and add

```
IDSV:       DS   8    ;Sector ID
                       Save area
```

Assemble and install as in the CCS manual."

CCS people I've consulted tell me this should work just fine and may prevent problems with other CP/M programs.

Mr. Willink has been using Target Plannercalc 1.01 for some time. In general he likes it, but finds a few problems. "If you should create a model and run out of memory, that model becomes useless even after you have deleted portions to decrease the size. Also I have found that there can be letter combinations in the heading of the model that cause the system to reboot instead of saving changes. . . . Otherwise, I find it well worth the $50 price." (I understand that the price has been increased to $99.)

I'm sending a copy of his letter to Comshare Target.

Really Great Paper

One problem with text printed by computer is that it has those telltale featheredges. I remember MacLean trying all kinds of gimmicks, including a terribly expensive bone paper separator, but nothing worked.

That's no longer true. I've been sent a sample of smooth-edge 20-pound bond that has perforations so fine I wouldn't have believed it came from tractor-fed fanfold if I hadn't torn it apart myself. I expect this to catch on; I may even have my letterhead printed on it.

Of course it costs about twice what regular fanfold costs.

Things My Postman . . ., Part 2

I do read all my mail, and I try to answer it. However, it's getting beyond my capabilities.

I'm attacking the problem in several ways. First: we're adding a microcomputer intern to the staff. That will let us get at a lot more software.

Second: I enjoy letters and most of them contain really valuable information. Reading the mail isn't the problem, it's answering it. You can help by enclosing a self-addressed stamped envelope, and please leave room on your original letter for a reply. It's comparatively easy to write an answer on the bottom of your letter and put the whole thing back in an envelope; while if we have to fire up the machines to write an answer, it may not get done at all.

Third: make sure your address is on the *letter itself*, not just the envelope. Envelopes often vanish.

Fourth: if you have information and questions, it helps a *lot* if you put them on separate sheets of paper. That way I can send you back the sheet with your questions and keep the one with the information. This is particularly important if what you've sent me is a complaint that you want sent to someone whose products I have favorably reviewed.

Fifth: I don't mind being warned about defective products; indeed, if I've recommended them I very much want to hear. But I can't solve the problems of the world. If you bought something I haven't recommended, I'll be glad to hear from you, but I'm unlikely to do anything about it.

Finally: those who have products they want reviewed should make it clear that's what you have in mind. Please don't send me long brochures and complicated order forms. I am not likely to buy your products, and if I were to buy them, it would most likely be at a computer show.

Regarding review items: I am not an agent or employee of BYTE. Materials sent to me through BYTE are forwarded; but review materials simply sent to BYTE aren't likely to reach me. If you want a BYTE review of your product, please direct your inquiries to the editorial staff. If you want *my* evaluation, your best route is to send me a letter describing what your product does, making it clear what I should do and what conditions you expect me to accept. We will then make direct contact and send you a statement of policy.

If you're interested in both formal review by the BYTE staff and my evaluation, do both of the above.

The Future

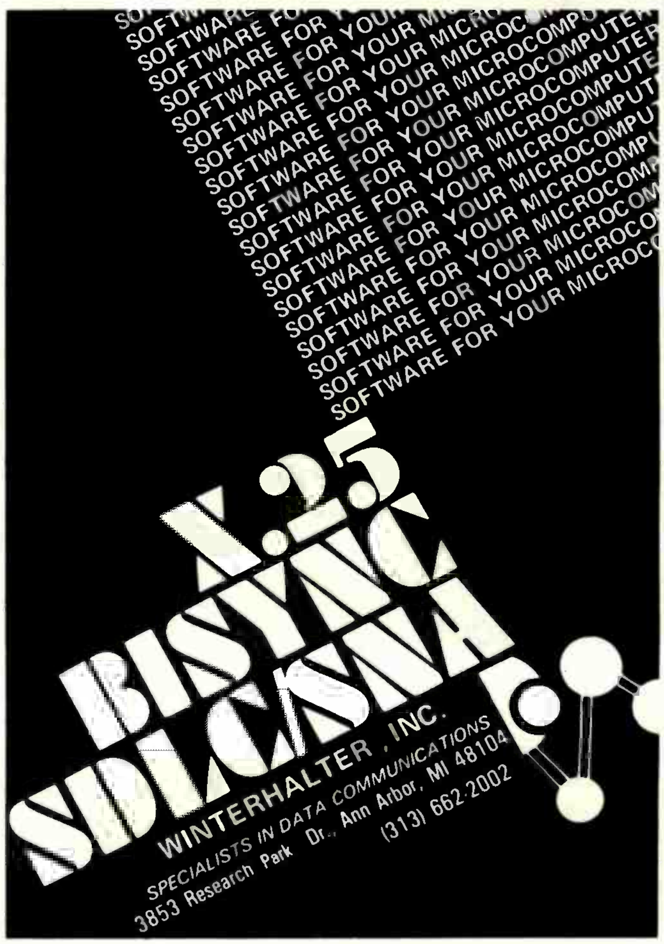
Coming soon: a big roundup of C compilers. I have almost a dozen, and some are excellent.

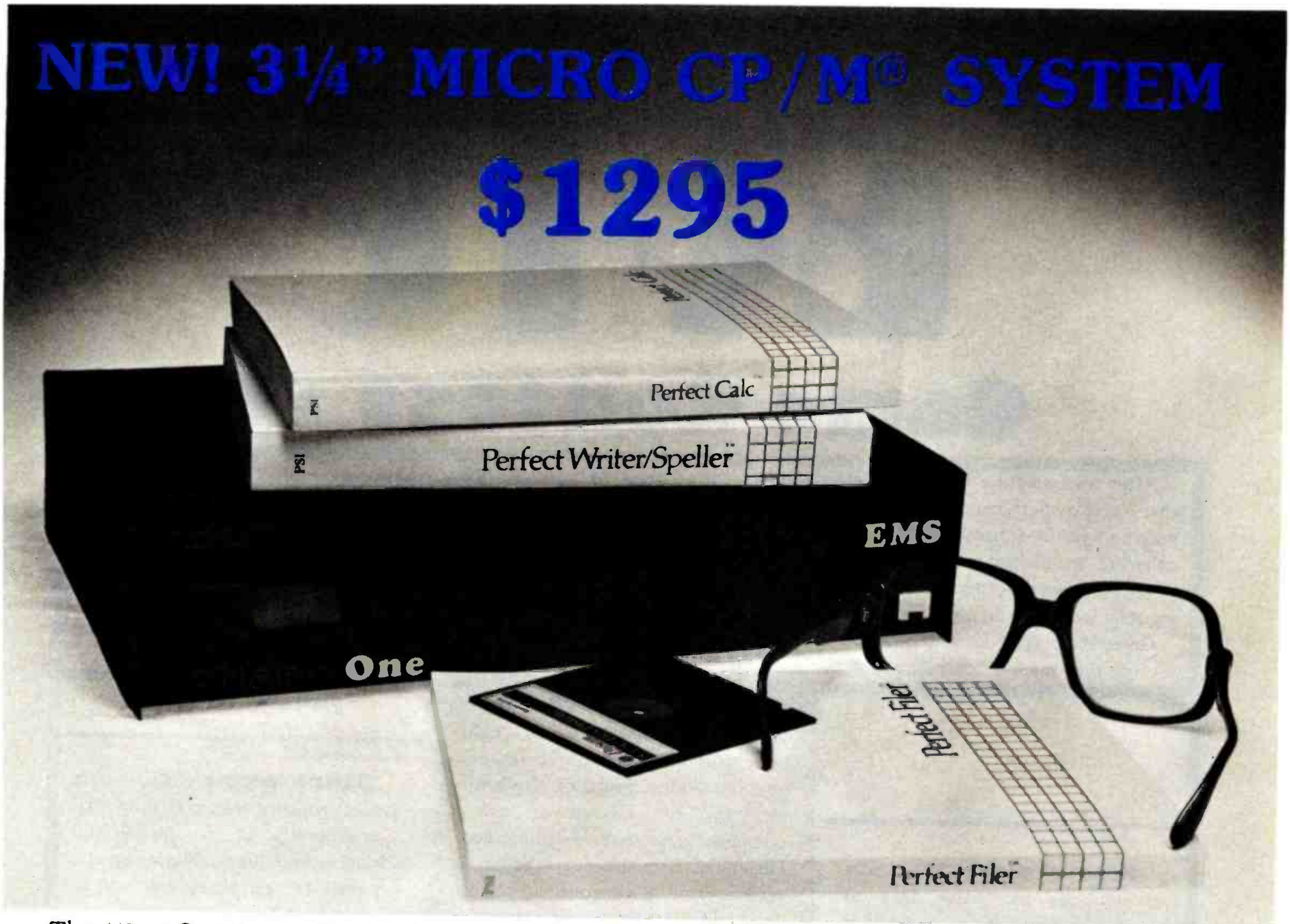
Also, a great number of you have taken the trouble to use my "benchmark" program with a number of languages and systems. I've made a few more tests myself. It's time to collect all those times into one monster chart. I'd have done it for this month, but Larry and I had to go to the desert. ■

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.

About the Author

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





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BYTE Game Contest #2

After reviewing the 77 entries we received for the second BYTE game contest, we think it's safe to draw the inference that Apple owners are enthusiastic game players. Of the total number of entries, 26 were written for the Apple II. The remaining two-thirds break down this way: 16 for the TRS-80 Color Computer, 10 for the IBM Personal Computer, and the other 25 are divided among the TRS-80 Models I, II, and III, the Commodore VIC-20, and the Atari 400 and 800.

We will have a pictorial essay on the winning games in the September 1983 issue of BYTE. It will include details on ordering selected games in disk format. Look for us then.

Given the preponderance of Apple-based entries, it should come as no surprise that the majority of the winning games are for the Apple II. Here are this year's winners:

First place ($500 cash prize plus a custom BYTE jacket) goes to Aaron Pratt of Ypsilanti, MI, for his two-player two-computer tank warfare game called Dual Duel. Reminiscent of the Atari arcade game Battlezone, it places you inside a tank driving around a plain containing several obstacles such as two pyramids and two blocks, and an enemy tank. As you move, the three-dimensional scenery changes in real time. The object of the game is to be the first to "kill" the enemy tank 10 times; it runs on two Apple IIs, two Atari 800s, or one of each.

Second place ($300 and a jacket) goes to Shawn Day of British Columbia for a simple but professional-looking Apple assembly-language arcade game called Sizzle. As alien invaders drop to the ground, you push a barbecue cart across the bottom of the screen trying to catch as many as possible. Other factors complicate the game.

Third place ($150 and a jacket) goes to William P. Porter of Coral Springs, FL, for his TRS-80 Model I game, Juggle. Playing against yourself in real time, you try to keep as many video "balls" as possible in the air at one time.

Fourth Place ($100 and a jacket) goes to C. Anthony Ray of Urbana, IL, (second-place winner of last year's contest) for an interesting arcade-type Apple II game called It's the Pits. You maneuver an animated Grimpit through a maze in search of nutritious yumyums. Several complications make the game more interesting; one such complication is that the maze "walls" are actually pits—one false move, and you've "killed" one of your three Grimpits.

Fifth place ($100 and a jacket) goes to William Hubbard of Tuscon, AZ, who wrote an Applesoft strategy game for the Apple II called Rescue. To play, you fly a rescue helicopter over islands in the Pacific Ocean in search of stranded ocean-liner passengers.

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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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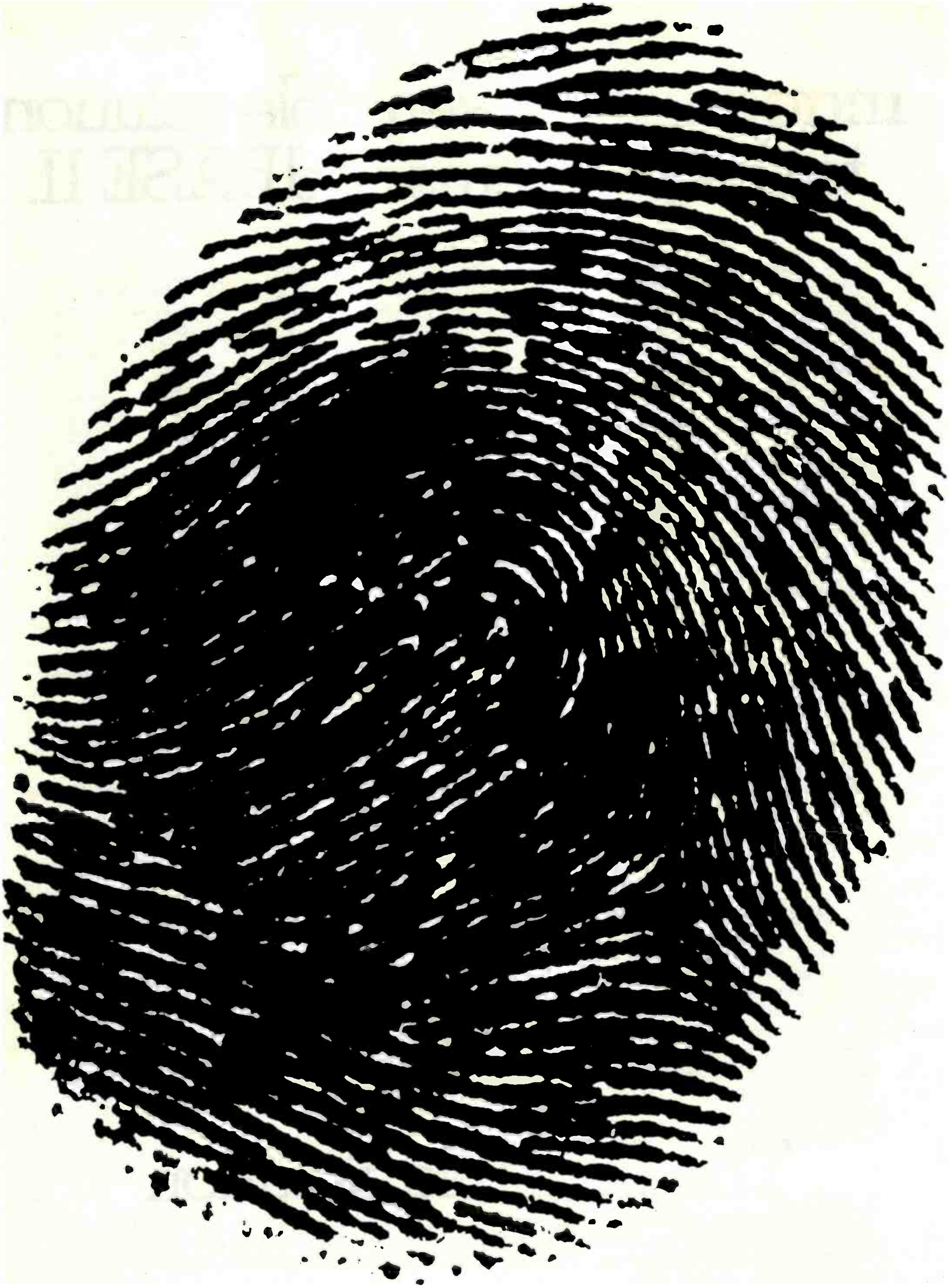

CP/M Plus

This new disk operating system is faster and more efficient than CP/M

by Mark Dahmke

CP/M Plus is an advanced disk operating system for 8-bit microcomputers, the latest in a series of systems from Digital Research. CP/M Plus includes all the familiar features of its predecessor, CP/M version 2.2, but it is much faster and much more efficient. For example, it automatically logs in new disks whenever they are inserted into the disk drives. And, with certain disk drives, it can even let you know when the disk drive door is open.

At a Glance

Name
CP/M Plus

Type
Operating system

Manufacturer
Digital Research
POB 579
Pacific Grove, CA 93950
(408) 649-3896

Format
8-inch floppy disk (CP/M format); other formats available from various manufacturers

Computer
Most computers that use one of the 8080 family of microprocessors (8080, 8085, or Z80)

Programs and Utilities Included
DATE, COPYSYS, DEVICE, DIR, DUMP, ED, ERASE, GENCOM, GET, HELP, HEXCOM, INITDIR, LIB, LINK, MAC, RMAC, PATCH, PIP, PUT, RENAME, SAVE, SET, SETDEF, SHOW, SID, SUBMIT

Price
$350

Before we discuss CP/M Plus, however, I'd like to give some background information on CP/M itself. CP/M stands for Control Program for Microcomputers. Developed by Digital Research for the 8080 microprocessor, it is now widely used on 8085-, Z80-, and 8080-based machines as well as on the newer 16-bit microcomputers, such as those based on the 8086 and 8088. (CP/M-86, for example, runs on the IBM Personal Computer.) It is also available for the Motorola 68000 in the form of CP/M-68K. People often find the name CP/M confusing because it doesn't adequately describe the program's purpose. CP/M is actually a DOS (disk operating system), as are Apple's DOS 3.3 and Radio Shack's TRSDOS.

CP/M was developed in 1973 by Gary Kildall, then a consultant to Intel, who wrote it for use on his own Intel development system. Many microcomputer manufacturers later decided to adapt CP/M to their hardware rather than develop their own operating systems. Consequently, a large user base began developing as early as 1975. CP/M experienced several revisions—from a version that could run only on the Intel MDS development system to a more flexible version that could be adapted to other computers in a hardware mix-and-match style. As more manufacturers decided to use CP/M, more software was written for and adapted to it. Although CP/M has its faults, the microcomputer industry has made that program its de facto standard.

Why CP/M?

CP/M is included as the standard operating system on many 8080 and Z80 computers, such as the Osborne 1. It is also available for such computers as the TRS-80 Model II and the Apple II. The former machine comes with a Z80 microprocessor and readily adapts to CP/M.

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Software	MS DOS Advanced Basic (Microsoft) Advanced User Interface*
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Drives	5¼", 320K bytes, IBM compatible Virtual Ram Disk (Up to 160K)*
Display System	7" Non-glare amber Graphics – IBM PC compatible Full 80 x 25 character format Auto screen off for prolonged life
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Parallel Port	Centronics/IBM compatible*
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***These extras worth over $1000.**

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Acoustic Cups	Uses internal modem
Expansion Chassis	5 or 10 MB of hard disk Up to 7 slots for IBM compatible cards
Carrying Case	Attractive case with accessory pockets
Multiplan†	Hyperion enhanced
123†	Hyperion enhanced
IN:SCRIBE	Word processor

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†Word Star is a trademark of Micropro International Corp.
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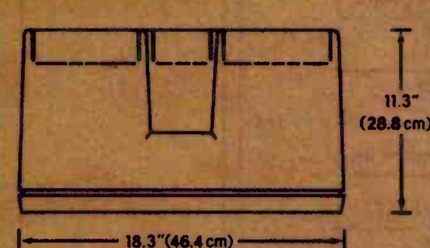
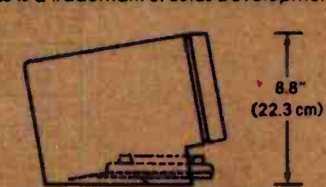
†Multiplan is a trademark of Microsoft Corp.
†123 is a trademark of Lotus Development Corp.





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(TRSDOS, Radio Shack's standard operating system, is similar to CP/M, but not sufficiently similar to permit it to run CP/M programs directly.) Running CP/M on the Apple II requires the addition of a Softcard from Microsoft. Although using a Softcard lets you run CP/M-based applications programs on an Apple II, that approach might not be the best way to gain access to the wide range of CP/M-compatible software on the market. One problem arises because many CP/M business software packages require 8-inch disk drives with 240K bytes of disk space on each drive. You can provide this capacity on an Apple II with add-on boards; however, your total investment to upgrade that system would cost you approximately as much as a new CP/M-compatible system would.

What Do You Get When You Run CP/M?

CP/M consists of several subsections. The first one is the basic disk operating system, or BDOS, the coordinating entity that accepts commands in the form of a code number and optional data or address values that specify the action to be performed. It then calls on the basic input/output system, or BIOS, for help in carrying out your instructions. The BIOS is customized to a computer system. It has device drivers coded in assembly language that perform such functions as disk read/write, console-input, console-output, and printer-output operations.

Another important part of CP/M is the console command processor, or CCP. The command processor runs

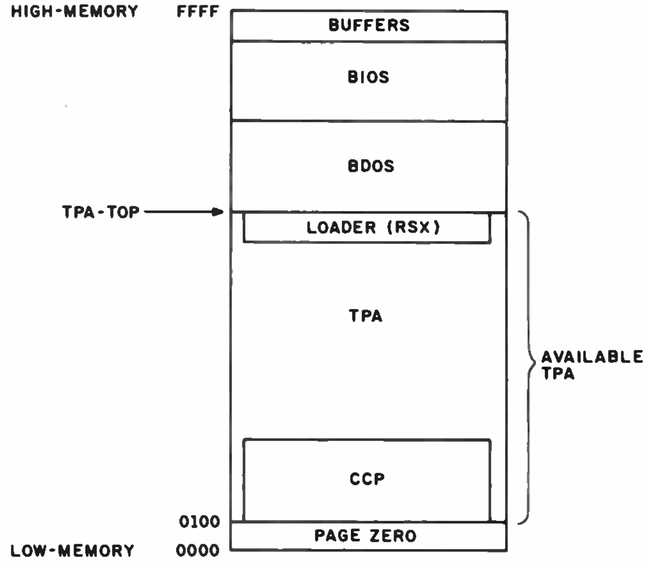

Figure 1: *The CP/M Plus nonbanked-memory organization. As in CP/M 2.2, the first page (256 bytes) of memory is reserved for the operating system. The TPA (transient program area) starts at location 0100 hexadecimal and extends to the bottom of the BDOS (basic disk operating system). The BIOS (basic input/output system) starts at the top of the BDOS and extends to the top of available memory. The LOADER is a resident system extension used by the CCP (console command processor) to load programs; it can also be called by a user program. The CCP is treated like any other program in CP/M Plus; in contrast, it's loaded at the top of the TPA in CP/M 2.2.*

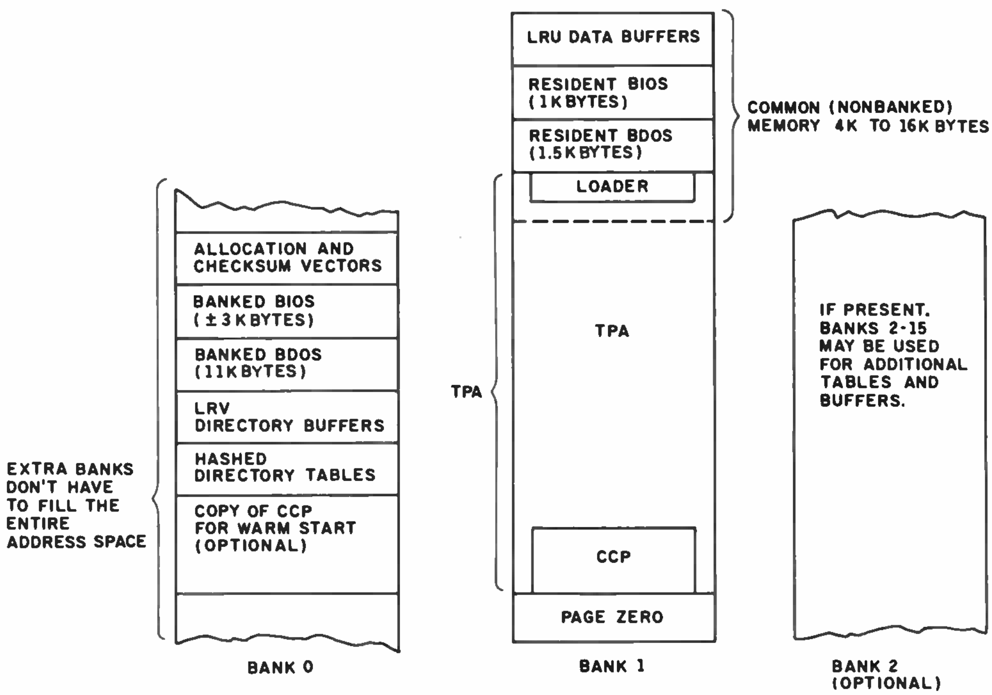

Figure 2: *The CP/M Plus banked-memory organization. Up to 16 banks can be supported, although only two are required for operation of the banked version. Bank 0 contains the bulk of the BDOS and BIOS as well as all the extra buffers. Bank 1 is used to run programs and contains a small part of the BIOS and BDOS in common memory. The block of common memory must be at least 4K bytes long and must reside at the top of the address space.*

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when no other program is running. When you see "A>" on your terminal, for instance, the command processor is in control and the default disk drive is drive A. The right-pointing arrow means that the computer is ready for your next command.

CP/M was designed to fulfill a need in the microcomputer industry. Although not the last word in operating systems, it is an optimal design that has proven portable over a wide variety of microcomputer systems.

System Organization

The new CP/M Plus has the same basic memory organization as the older CP/M 2.2 (see figure 1). Page zero is reserved for system use, and the TPA (transient program area) begins at location 0100 hexadecimal, as it does in earlier CP/M versions. The BDOS resides above the TPA, and the BIOS is loaded at the top of memory. In CP/M 2.2, the CCP, which accepts and processes system-level commands, always resides in the TPA just under the BDOS; in CP/M Plus, however, it is loaded at location 0100 hexadecimal and treated just like any other program. To facilitate loading programs into memory, a module called the LOADER resides just below the BDOS and remains there permanently. When you request that a program be loaded into the TPA, the CCP calls the LOADER, which in turn gets the program from disk and places it in memory on top of the CCP (at 0100); the program can extend up to the bottom of the BDOS, if necessary.

CP/M Plus can manage from 2 to 16 banks of memory. Figure 2 shows the organization of a typical banked system. At least the top 4K bytes of one bank must be common to all banks; usually, the top of bank 1 serves as the common (nonbanked) memory and the top locations of all other banks are disabled. Therefore, although many 64K-byte S-100 memory boards allow individual bank selection of each 16K-byte segment, CP/M Plus permits banking of the bottom 48K bytes of all boards while requiring that one of the 16K-byte banks, at the top of memory, be resident at all times. The TPA can extend up into the common bank, and the resident portions of the BIOS and BDOS must lie entirely within the common bank.

File-System Features

The CP/M Plus file system has been greatly improved compared with CP/M 2.2. CP/M Plus supports files up to 32 megabytes long, as opposed to an 8-megabyte limit with CP/M 2.2, and it supports disk capacities to 512 megabytes, contrasted with 8 megabytes for CP/M 2.2. As does CP/M 2.2, CP/M Plus supports as many as 16 logical disk drives.

The major throughput improvements of CP/M Plus stem from directory hashing and an LRU (least recently used) buffering technique. In the former procedure, available using both banked and nonbanked versions, the BDOS creates a hashing table of directory entries for a disk when that disk is logged in. Therefore, when a file is opened or closed or when a new extent is selected, the

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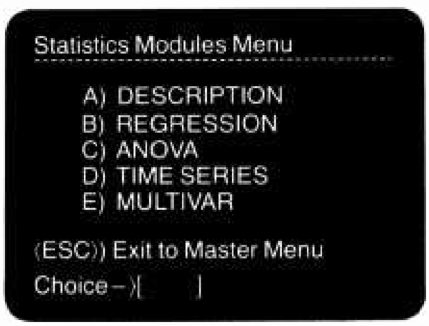

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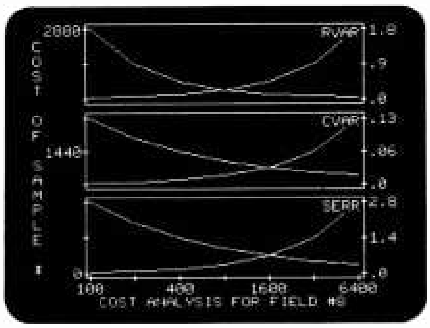

STATPRO offers a comprehensive collection of statistical procedures.
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STATPRO documentation wraps up the package.
Although STATPRO software is essentially self-documenting, complete print documentation is provided. This includes a walk-through Introductory Tutorial, a Menu Chart, and a comprehensive User's Guide for each STATPRO component.

STATPRO currently runs on all versions of the Apple® II personal computers. It will be available for the IBM® PC in September.

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BDOS need only consult the hashing table; it need not perform a linear search of the disk directory, a step required in earlier CP/M versions. This one feature is responsible for the greatest improvement in CP/M Plus's file-system response time.

The LRU technique, supported by the CP/M Plus banked version, speeds access to files by storing as many records in main memory as possible. Multiple record-storing buffers can be allocated in any bank except bank 1; buffers are allocated and deallocated as required by the BDOS. When a user program requests a record not in main memory, the BDOS throws away the least recently used record, thus freeing that buffer for the requested record. When a file must be written to memory, the BDOS writes existing records to disk, thus freeing a buffer to accept the new record. Such techniques are used on large computers to speed file I/O (input/output) operations and to implement virtual-memory schemes.

Multisector I/O

CP/M Plus includes a multisector I/O capability that allows efficient loading of a large block of records. Setting the multisector count value informs the BDOS that *n* records are to be read or written when the next BDOS Read or Write function is encountered. This feature has two advantages. First, in a computer system that supports a high-speed data-transfer capability such as DMA (direct memory access), a large block of data can be loaded without the inefficiencies involved in reading a record at a time from disk. For example, when reading from a hard disk, it might be possible to load an entire track at once, store the data in a large buffer, and then sort the records into order. (This sorting gets around problems related to sector skewing, a method of staggering sectors around the disk to take advantage of the disk's rotational delay when reading or writing a disk.)

The other advantage to multisector I/O is that it simplifies programming. A single command can be used to load an entire program or block of data, avoiding the need to process sectors and keep track of pointers in an assembly-language program.

Automatic Disk Logging

Perhaps CP/M Plus's greatest advantage is its ability to automatically log in disks whenever a new disk is read. Actually, CP/M Plus doesn't notice a change in disks until it tries to read the disk directory; it does eliminate the old "BDOS ERR R/O" error message. CP/M Plus also supports disk drives that have a door-open status bit. If this door-open bit is used to generate a hardware interrupt, then CP/M Plus can force the Media Flag, which in turn informs the BDOS that there might be a new disk in the drive. Before performing any input or output operations on the disk, it relogs the disk.

Time/Date Stamps

CP/M Plus supports time and date stamping of files by reformatting the disk's directory. Every fourth directory entry is used to keep track of the stamps for three files.

Continued on page 371

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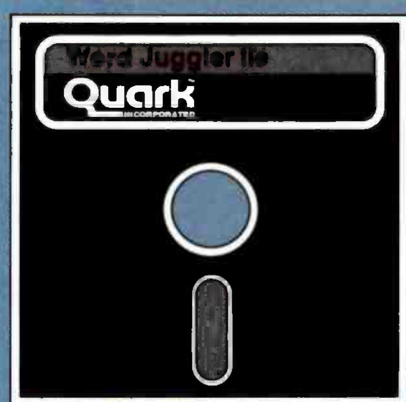

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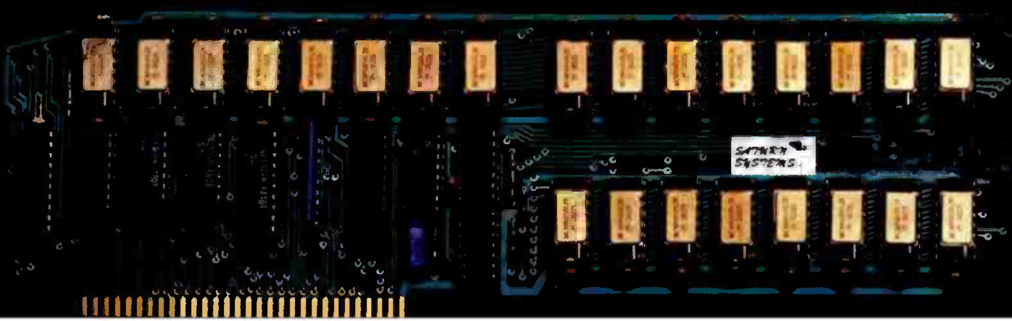

You can activate time/date stamps for files when updated, created, or accessed. Because only two stamps can be kept for each file, you must choose between stamping files on creation or on access. The update stamp is always available and need only be enabled by the SET command. Before time/date stamping can be used on a disk, the utility INITDIR must be run to reformat the directory. Because the stamps take up every fourth directory entry, some directory space is lost on the disk.

Password Protection

Files can be password protected in the banked version of CP/M Plus. The password-protection mechanism is identical to that used in the MP/M operating system. *Floating* directory entries keep track of a file's password, and CP/M Plus must search through the directory to find the password entry for a file. A default password can be set for all files created on a disk.

I/O Redirection

CP/M Plus supports a more generalized character I/O redirection scheme than do previous versions of CP/M. Each of five logical device names (CONIN, CONOUT, AUXIN, AUXOUT, LST) can be assigned to one or more physical devices. Up to 12 physical devices can be defined, and all logical devices have access to all physical devices. The DEVICE command lets you reassign physical devices, change device characteristics, and determine current assignments.

Many operating systems, such as Unix, allow disk files to be treated as character I/O devices. CP/M Plus supports a GET and PUT facility that allows console input and output and printer output to be redirected to or from a disk file. The command "GET CONSOLE INPUT FROM FILE filename.typ" causes all subsequent console input to come from the file specified in the command. If the SYSTEM option is added after the file name, even system-level CCP commands come from the file, thus allowing the GET facility to function as a batch-command execution system similar to that of the SUBMIT command.

System Utilities

CP/M Plus provides some new utilities not available on previous CP/M versions. For example, the HELP command lets you request information about CP/M Plus and its commands by entering the name of the command or program. One or more screens full of information then appear on the desired subject. Because CP/M Plus knows the screen size (number of rows and columns), it can paginate the display so that you can read it comfortably without having to manually start and stop scrolling. Most HELP topics include subtopics, such as lists of options or examples. If you are interested in the DIR (directory) command, for example, you can enter HELP DIR. At the end of the DIR display, a list of subtopic headings appears, including EXAMPLES. You can at that point just type .EXAMPLES to go to the subtopic. The period

before the subtopic name specifies a subtopic of the last topic rather than a new major topic. From the CP/M Plus prompt level you can enter HELP DIR EXAMPLES to go directly to the subtopic. If you just type HELP at the CP/M Plus level, you get a list of available topics.

The HELP command even lets you edit the HELP.HLP file that contains all the text for the help messages. The command HELP [EXTRACT] converts the HELP.HLP file into a HELP.DAT file so that you can edit it with a word processor. The HELP [CREATE] command converts your edited text file back into a HELP.HLP file so that it can be accessed by the HELP command. By employing these commands, a vendor with special utility programs or special hardware can add personalized help messages to the system.

CP/M Plus still has many of the familiar built-in commands of version 2.2: DIR, REN, ERA, TYPE, and USER. The only one not included is SAVE, which has been converted into a transient command. Most of the built-in commands operate similarly to their CP/M 2.2 counterparts. However, in CP/M Plus all of them have transient-command versions as well, a feature that keeps the CCP small enough to fit in the system tracks, as it does in CP/M 2.2, despite CP/M Plus's enhancements. The extra features of these commands are handled by transient versions (DIR.COM, ERASE.COM, etc.). For example, the DIR transient command has extra options that can be listed in square brackets after the normal command tail of the DIR built-in command. The CCP recognizes that the transient version is required and loads it. If it isn't found on the disk, the CCP issues an error message. Some of the options provided in the enhanced DIR command include DRIVE=ALL, which causes all files on all drives to be listed; EXCLUDE, which displays all files not specified in the DIR command tail; SIZE, which displays the size in kilobytes of all files; and FULL, which displays all information about all files on the disk (similar to the old STAT command).

The TYPE command in CP/M Plus has a page mode (the default mode) that causes text to be displayed screen page by screen page, with a prompt appearing at the bottom of the screen that tells you to press Return to see the next page. This avoids the old problem of having to use Control-S to start and stop scrolling.

The PIP (peripheral interchange program) is a generalized file-copy program that lets you transfer files from one disk to another, from disk to a character device (such as the printer), or from a character device to a disk file. It also lets you concatenate files and perform other text-formatting functions. In CP/M Plus, PIP operates in the same manner as does the CP/M 2.2 version.

In CP/M 2.2 the STAT command performs a wide variety of functions. In CP/M Plus the display- and system-alteration commands have been separated into different utility programs. SETDEF lets you change the drive search order, the file-type search order, and the temporary drive. The drive search order is another new feature of CP/M Plus. When set, CP/M Plus automatically searches other disk drives for a file if the file can't

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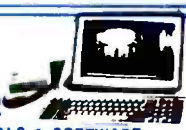

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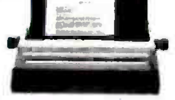

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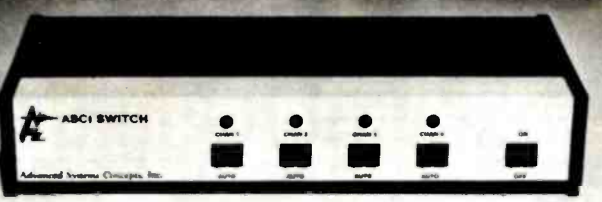


be found on the default or requested drive. The temporary-drive specification lets you select the drive where temporary files (created by text editors and various utility programs) are created. SETDEF also lets you turn the page-display mode on or off.

The SET command affects the disk directory, the drive, or one or more disk files. It lets you initiate password protection (on a banked system) and time and date stamping of files. It also lets you set file and drive attributes such as SYS (system files) or read-only. You can also use it to label a disk and password-protect the label.

In CP/M Plus you can assign a label to a disk to make cataloging it easier. The label can be password protected. If it isn't protected, anyone with access to the SET command can alter the attributes of a disk and make it inaccessible to you. The SET command can also be used to set passwords for individual files on a disk. Four levels of protection are available: none, read, write, and delete. If read is set, a password is needed for all actions such as reading, copying, writing, deleting, or renaming a file. If write protection is set, you need to enter a password only to write, delete, or rename the file, not to read it. The delete level lets you write or read but not delete the file. To set the password for a file, you enter the following command:

```
SET MYFILE.TXT [PASSWORD=SECRET,
                PROTECT=WRITE]
```

This command sets the password and protects the file against writing—but not against reading. SET also lets you set a default password for the entire time you are using the computer (until you restart CP/M Plus or hit Reset).

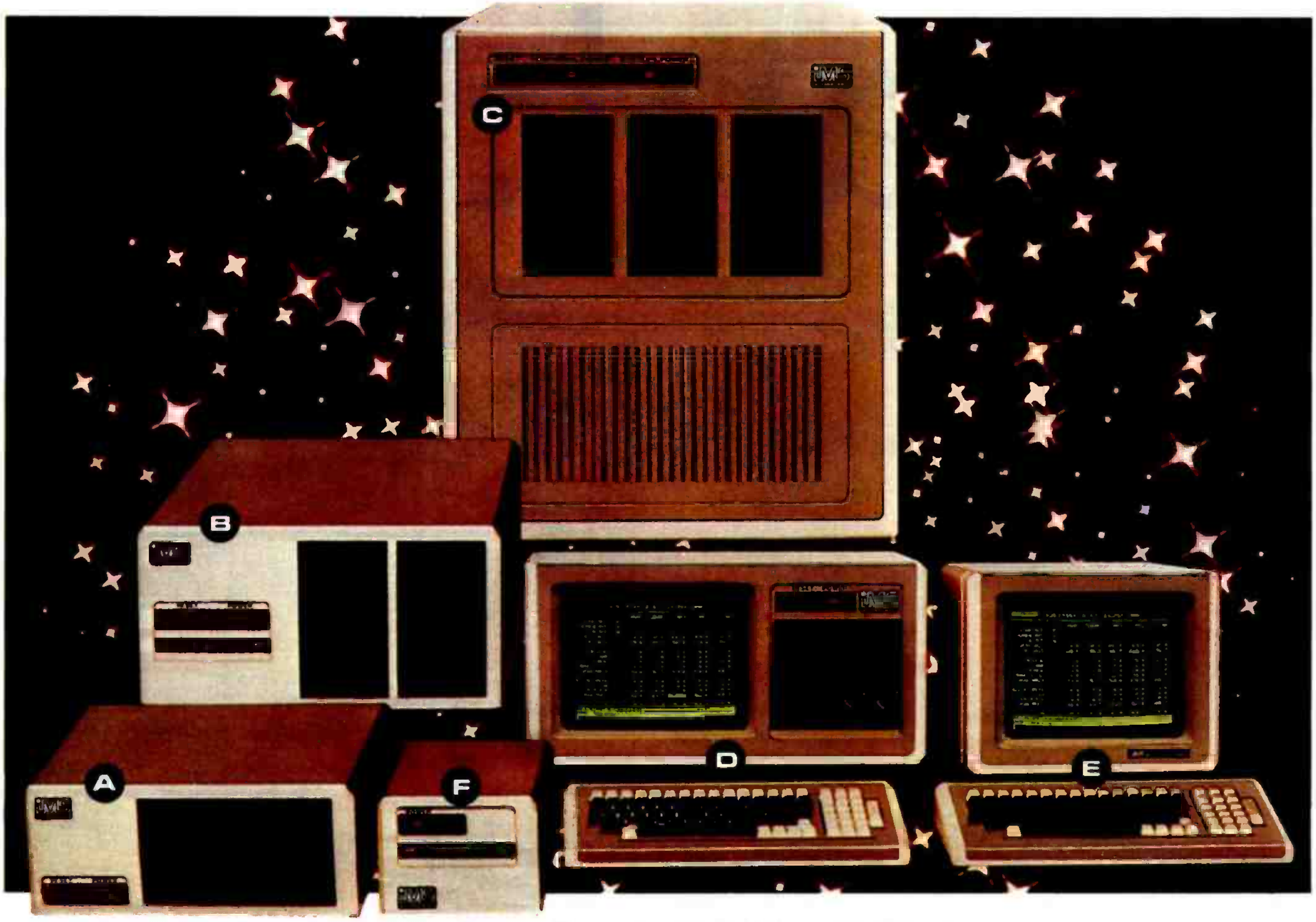
CP/M Plus supports an expanded group of file attributes. CP/M 2.2 allows the attributes RO, SYS, DIR, and RW. CP/M Plus uses some of the remaining bits in the file-control block to implement an *archive feature* and four user-definable attributes. The archive attribute works with PIP when the PIP "A" option is set. PIP can be given an ambiguous file specification (such as *.*, meaning "copy all files"); it then copies only the files that have the archive-attribute bit turned off. Thus, only files that have not been backed up are copied. As the files are copied, PIP turns on the archive bit, indicating that the file has been backed up. Therefore, all files that have been created or changed since the last PIP archive are backed up automatically.

The 4 user-definable bits in the file-control block can be used under program control for any purpose. The SET command can be used to change their values, or they can be changed under program control through the BDOS.

The SHOW command displays information about a disk drive. This information includes the disk label, access mode, free space, current user number, number of files for each user number on the disk, number of free directory entries on the disk, and the disk-drive characteristics. SHOW takes over many of the status-display

Continued on page 378

The IMS Computer Family



All IMS systems can be configured with 8 bit or 16 bit microprocessors.

Ⓐ Ⓑ 5000SX/8000SX

The SX table top computer systems are the ideal choice for companies with expansion in mind. These systems are easily expandable from one to eight users, each having his own Microprocessor, 64K of memory, and local peripheral control.

Ⓐ The 5000SX chassis has three full width 5¼ inch Floppy/Winchester slots available. Winchesters from 6.3 MByte to 19.2 MByte require one full width slot each. Floppies from 500 KBytes to 1.0 MBytes of storage require ½ slot per drive.

Ⓑ The 8000SX chassis has two full width 8 inch Floppy/Winchester slots available with the added capacity to house a magnetic tape bulk memory subsystem. Winchesters from 6.3 to 85 MByte storage require one full width slot each and 1.6 MByte Floppies require ½ slot per drive.

Ⓒ 8000S "MAXIMA"

The IMS 8000S "MAXIMA" Computer system is designed for the company where many people must have access to a large common pool of information. Basically the system configuration of the 8000S is similar to that of the SX Table Top system with the added capability to support up to 16 users each with his own Microprocessor and 64K of memory. The 8000S has five full width 8" Floppy/Winchester slots available supporting any combination of full width Winchesters and ½ width Floppies plus a magnetic tape bulk memory subsystem.

Ⓓ 5000IS - "The Desktop Mainframe"

From the crystal clear monitor with a true typist keyboard to the high performance power supply—the 5000IS is the most versatile integrated system available—best of all, the 5000IS can serve as the host processor of a multi-user, multiprocessing system supporting four users.

Ⓔ IMS "ULTIMA" Terminal

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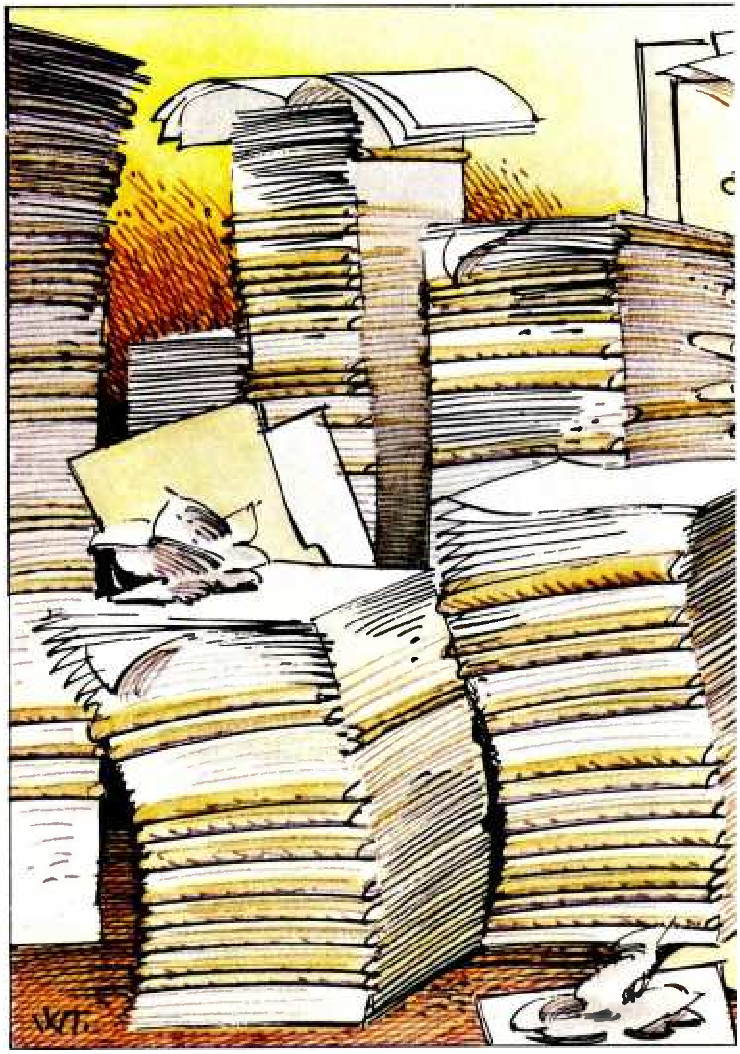

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Friday's the revolutionary new microcomputer information management system from Ashton-Tate, the people who invented dBASE II.™

It came in Tuesday, and it took me almost no time at all to get the hang of it because Friday works *with* me, not against me. I've already turned stacks and stacks of paper files into much more efficient "electronic files." And it's so easy to use that even Mr. Bundtweiller can do it.

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The total number of #3455 Brass Beds sold year-to-date, by region.

A quick report on our cash receivables.

Or the special report for the Board of Directors meeting this afternoon. Mr. Bundtweiller forgot to tell me about it until just before lunch, but Friday and I got it done in no time at all. It looks gorgeous!

Friday even knows how to keep private or confidential information to itself unless I ask for it using a special password.

Friday's helped me say goodbye to paper shuffling forever. It's terrific for inventory and invoices and paychecks and input screens and reports. It works with dBASE II™ and 1-2-3[1] and Wordstar[2] files. And the way it handles mailing lists and labels is just fantastic.

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functions of the old STAT command. For example:

SHOW B:

displays the following:

B: RW, Space: 240k

This tells you that the B drive is set to read/write mode and has 240K bytes of remaining space.

Another useful feature of SHOW is similar to the STAT DSK: command on CP/M 2.2. SHOW [DRIVE] displays the following information:

A:	Drive Characteristics
1944:	128-Byte Record Capacity
243:	Kilobyte Drive Capacity
64:	32-Byte Directory Entries
64:	Checked Directory Entries
128:	Records/Directory Entry
8:	Records/Block
26:	Records/Track
128:	Bytes/Physical Record

The Symbolic Instruction Debugger

Previous versions of CP/M included a debugger/tracer program called DDT (dynamic debugging tool, or a certain pesticide). It lets a programmer disassemble, trace, and test programs on an assembly- or machine-code level. CP/M Plus comes with SID, a symbolic instruction debugger, which performs all the functions of DDT, but also lets programs be debugged symbolically. This means that if a compiler or assembler is used that generates a symbol table (a list of symbols and labels and their hexadecimal machine addresses), the symbol table can be read into SID and used to display the original symbols at appropriate locations in memory. This feature greatly simplifies the debugging process because the programmer can see exactly where he or she is when stepping through the program, because the original references are preserved. SID also has improved numeric-expression-evaluation capabilities and some additional trace commands for single-stepping through programs.

Two other useful programs are included with CP/M Plus. MAC and RMAC are powerful macro assemblers that can be used for program development. Previous versions of CP/M came only with ASM, an absolute assembler with no macros and few other features. MAC has macros but generates absolute code, while RMAC produces *relocatable* code. RMAC is required if you intend to write or modify the BIOS or write resident system extensions (to be discussed later). Both MAC and RMAC come with macro libraries that simulate all Z80 instructions that are not part of the standard Intel 8080 instruction set. This lets the programmer take advantage of the powerful Z80 instructions while still using the assembler

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provided with the operating system. Including MAC and RMAC is a major step forward for CP/M Plus and is an important selling point.

To modify the BIOS or write some system extensions, it is necessary to link assembler modules together. LINK version 1.3A is included with CP/M Plus for this reason. This version of LINK has an extra option, B, which is used to link the BIOS for a banked CP/M Plus system. Earlier versions of LINK do not accept this command. LIB, a library-manager program, is included to let you develop and maintain libraries of linkable routines to be used by many programs.

Another major advance in the design of CP/M Plus is the GENCPM program. Previous versions of CP/M require that you follow a complicated and confusing sequence of steps to assemble and load a new BIOS and install a new version of CP/M. With CP/M Plus, you need only reassemble the modified part of the BIOS, relink it, and run GENCPM. GENCPM asks you a series of questions about how the system should be configured (for example, top of memory, whether hashing is used, whether you are installing a banked or nonbanked version, etc.) and generates a new CPM3.SYS system file for you. GENCPM is an incredible program in itself. It performs the same kinds of functions as a linker and handles all the configuration details as well. It even lets you create a GENCPM.DAT file that has the entire sequence of configuration questions in it. After you have gone through the generation process once, you simply type GENCPM AUTO and the entire process repeats automatically.

For example, if you have a working BIOS and wish to change the number of buffers, the top of memory, or the size of the console display (in rows and columns), you only have to rerun GENCPM and answer the questions differently. The BIOS need not be modified.

Batch Facility

As in CP/M 2.2, the SUBMIT command lets you execute a sequence of commands in unattended operation. This version of SUBMIT can also contain program input lines. Any line preceded by a "<" character is used as input to a program rather than as a command sent to CP/M Plus itself.

CP/M Plus lets you change the file search order (when you type in the name of a program to be executed). Normally, if you type in a command such as MBASIC, you are really telling CP/M Plus to search the directory for a file called MBASIC.COM and if found, to load and execute it as a program. CP/M Plus also (if you desire) searches for files with a file type of .SUB. The SETDEF command lets you select the desired search order: COM, or COM - SUB, SUB - COM, or just SUB. Thus, CP/M Plus might first search for a file called MBASIC (in this example) with a file type of COM. If it isn't found, the CCP tries to find a file of type SUB. If a submit file is found, it invokes the submit program and executes the entire sequence of commands found in the file.

For example, if you have a sequence of commands that you enter each time you load MBASIC, you can change the search order to SUB - COM, then create a file named MBASIC.SUB that contains the desired sequence. When you type MBASIC, CP/M Plus executes the submit file instead of the COM file. By changing the name of the actual MBASIC program to something else (MBAS, for example), you can then include the command in the submit file and have SUBMIT execute it for you.

Another nice feature of CP/M Plus is that, upon loading, it executes a file called PROFILE.SUB if one is found on disk. This capability allows a more straightforward means of executing a series of start-up commands than is available in previous versions of CP/M. For example, you can create a profile file that contains these commands:

```
DATE SET
SETDEF *,B: [ORDER=(COM,SUB)]
```

CP/M Plus first asks you to enter the date and time, and then it invokes the SETDEF utility to set the drive search order (default drive, then B: drive) and the search order for command and submit files.

Resident System Extensions

Many programs written for CP/M 2.2 automatically relocate themselves to the top of the TPA and change the top-of-memory pointer at location 0005 hexadecimal in memory. This is often done to free up the bottom of the TPA for other programs. Both DDT and SID work this way because the program to be debugged loads at location 0100 hexadecimal. To make everything work right, the program must first make sure that when the BDOS is called at location 0005 hexadecimal, control properly transfers to the BDOS. If desired, the program can intercept BDOS calls and check for a function that it is to perform. Some manufacturers implement RAM (random-access read/write memory) disks or hard disks this way to avoid having to modify the BIOS (see figure 3).

Digital Research has formalized this approach in the form of the RSX (resident system extension). RSX modules can be stacked from the top of the TPA down, theoretically, to the bottom of the TPA. Each RSX entry point must check for a BDOS call that it is supposed to handle and, if found, transfer control to that part of itself. If the BDOS call is to be handled by the BDOS or some higher RSX, it must pass it through to the next higher level. CP/M Plus includes a utility that creates an RSX and converts one to an executable COM file. This way, you can load an RSX by typing its name. The BDOS transfers control to it and causes it to relocate at the top of the TPA.

The RSX is a useful concept for vendors trying to support specialized hardware such as a RAM disk, hard disk, or some other I/O card or modification to a standard per-

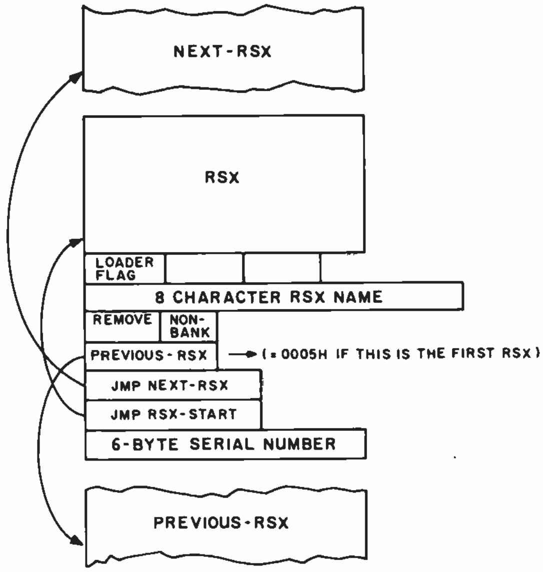

Figure 3: *The RSX (resident system extension) is a module loaded just under the top of the TPA that intercepts all BDOS calls from a program. If the BDOS call is one that the RSX should handle, it performs the desired function and returns to the caller. If the RSX doesn't recognize the function requested, it simply passes it on to the BDOS. An RSX can be used to implement extended hardware support for a computer (such as a RAM disk or hard disk), thus avoiding having to rewrite the BIOS to support new hardware.*

Func	Function Name	Comments
03	Auxiliary Input	Replaces Reader Input
04	Auxiliary Output	Replaces Punch Output
07	Auxiliary Input Status	
08	Auxiliary Output Status	
41	Test and Write Record	MP/M compatibility
42	Lock Record	MP/M compatibility
43	Unlock Record	MP/M compatibility
44	Set Multisector count	
45	Set BDOS error mode	
46	Get Disk free space	
47	Chain to program	
48	Flush buffers	
49	Get/Set system control block	
50	Direct BIOS calls	
59	Load overlay	
60	Call resident system extension	
98	Free blocks	
99	Truncate file	
100	Set directory label	
101	Return directory label data	
102	Read file date stamps and password mode	
103	Write file XFCB	
104	Set date and time	
105	Get date and time	
106	Set default password	
107	Return serial number	
108	Get/Set program return code	
109	Get/Set console mode	
110	Get/Set Output delimiter	
111	Print block	
112	List block	
152	Parse Filename	

Table 1: *New BDOS functions.*

BDOS Function 109 input parameter in registers DE:

Bit 0: 1 = Control-C only status for BDOS function 11.
0 = Normal status for function 11.

Bit 1: 1 = Disable stop scroll, Control-S, start scroll, Control-Q support.
0 = Enable stop and start scroll support.

Bit 2: 1 = Raw console output mode. Disable tab expansion for BDOS functions 2, 9, and 111. Disable printer echo, Control-P support.
0 = Normal console output mode.

Bit 3: 1 = Disable Control-C program termination.
0 = Enable Control-C program termination.

Bits 8, 9: Set console status mode for RSXs that perform console input redirection from a file.

Bit 8	Bit 9	Action
0	0	conditional status
0	1	false status
1	0	true status
1	1	bypass redirection

Table 2: *CP/M Plus lets you change the way the console responds to Control-C and other Control keys.*

sonal computer. For example, a disk containing the RSX can be shipped with the specialized hardware, eliminating the need for custom interface software or user modification of the BIOS source code (which may not come with the computer in the first place).

BDOS Enhancements

As discussed earlier, the BDOS has new features such as directory hashing, internal blocking and deblocking, and banked-memory support. It also supports RSX modules, time and date stamping, and password protection. Some new BDOS function calls have been added to make these features accessible. Table 1 lists some of the new functions.

CP/M Plus supports three error modes: Default, Return Error, and Return and Display. The Default mode simply displays an error message on the console device and terminates the program. The Return Error mode sets the A register to 255 (0FF hexadecimal) and places the error code in the H register, then returns to the program. The Return and Display mode first displays the error message on the console, then returns the error code to the program.

In previous versions of CP/M, some programmers were not happy going through the BDOS to perform such functions as console I/O. CP/M Plus includes BDOS function number 50 for direct BIOS calls. This lets the programmer set up registers and access the BIOS directly for special applications. Although the old method of locating the BIOS and calling it still works in CP/M Plus, it is not recommended for compatibility reasons.

Function number 107 will be praised by software vendors and despised by many users. When called, it returns the 6-byte serial number of the copy of CP/M Plus currently running.

It is now possible to read and set a program return code from within a program. This lets a series of programs being chained into memory read the return code of the previous program to determine if it terminated normally or not. The program return code is also used to pass an abnormal end code to subsequent batch jobs in a submit file. Thus, you can set up a batch job stream to compile, link, and execute a program without intervention. If the first or second steps of the sequence aren't completed properly, the remaining steps won't execute.

In CP/M Plus the mode of the console can be queried and altered using function 109. Table 2 shows the console-mode bits and their values. One useful mode control lets the Control-C key be deactivated during program execution to prevent you from terminating a program with files still open.

Finally, most specialized MP/M functions such as Lock and Unlock Record are included in CP/M Plus for program-level compatibility, although these functions do nothing in CP/M. Also, the Parse Filename function is included to simplify decoding of file specifications (file name, file type, drive, and password). Because this function is used by some high-level languages, Digital Research decided to include it in CP/M Plus.

Modular BIOS Concept

The CP/M Plus BIOS is similar in many ways to CP/M 2.2's BIOS and in some ways is easier to implement. The disk blocking and deblocking function has been removed from the BIOS and placed in the BDOS to improve performance. However, many other features of the new BIOS make it considerably more difficult to install; the banked-memory-support feature proves the most difficult.

The CP/M Plus BIOS can be developed in one huge

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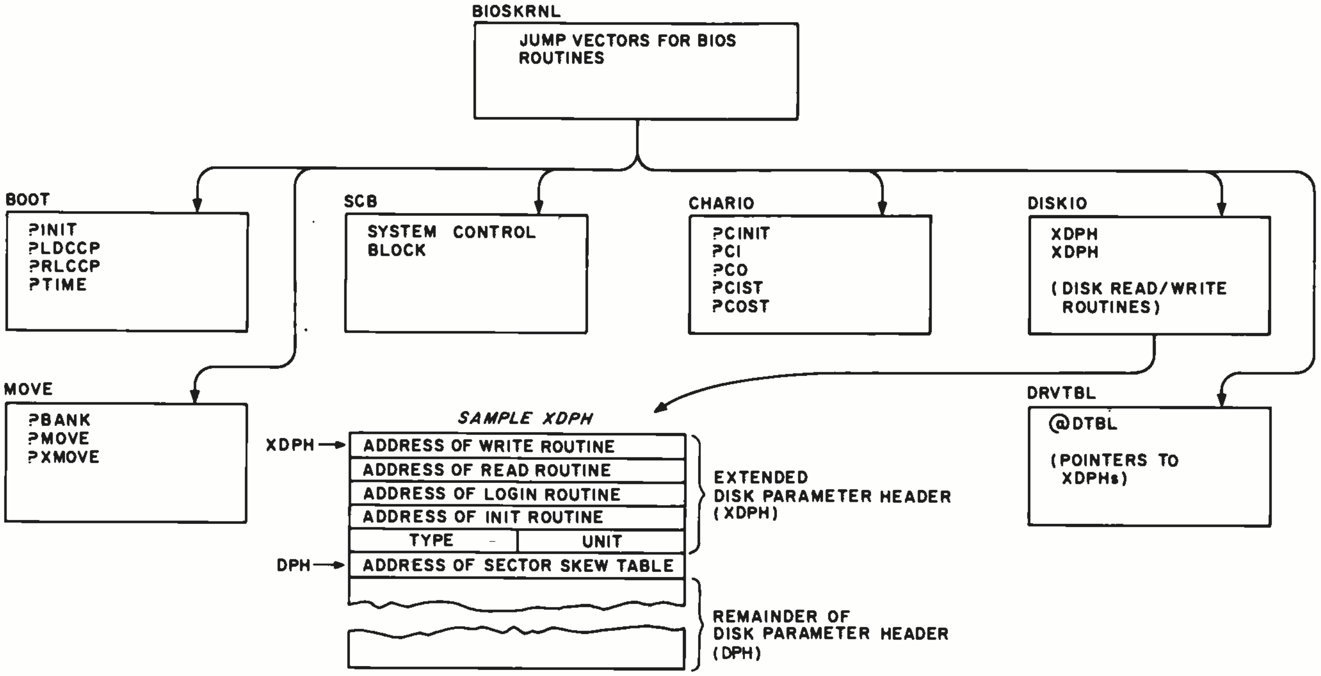

Figure 4: *The linkable modular BIOS can be broken into several easy-to-maintain segments, as shown here, allowing a manufacturer to supply a disk I/O module with its disk-controller board without having to worry about making the rest of the BIOS compatible. In the same way, character I/O devices can be separated into modules to simplify system integration. Furthermore, breaking the BIOS into logical sections makes it easier to maintain and modify.*

source file, as can the 2.2 BIOS. Because you must use the linker program to generate an SPR (system page relocatable) file, however, you might as well break up the BIOS into manageable pieces. Digital Research provides the assembler source file for a BIOS kernel, which is not to be modified under any circumstances. It contains the jump vectors that the BDOS interfaces with and supports the disk modules and character I/O modules. The manual lists a series of subroutines that must be written by the systems programmer to interface with the BIOS kernel. These routines include Load CCP, Reload CCP, disk init, character device init, read character, write character, and so on. This level of organization actually makes the BIOS easier to write once you get out of the habit of writing actual BIOS subroutines, as was done in CP/M 2.2 (see figure 4).

All the modules of the BIOS—bioskrnl, chario, diskio, boot, move, scb, and drvtbl—can be assembled with RMAC and linked together using the supplied LINK version 1.3A. You must specify the "OS" option in the linker to generate an SPR file (called BIOS3.SPR).

Conclusions

CP/M Plus turns CP/M into a professional operating system that makes up for many mistakes of the past. It supports the automatic log in of disks, which in the end may be its most significant selling point. In benchmark tests, it performs disk data transfers from 4 to 10 times faster than CP/M 2.2, depending on the hardware of the system and the way the BIOS is written. It supports banked memory, which allows for larger buffers, more BDOS functions, and a larger TPA for user programs.

The nonbanked version of CP/M Plus is slightly larger than CP/M 2.2; therefore, about 2K bytes of TPA are lost. This really isn't a problem with most software packages because few require all that space to operate.

CP/M Plus is not without its problems. I have been writing and modifying BIOSes for CP/M for several years and it took about one full-time week to make CP/M Plus work. This was primarily due to the problem of extricating the disk read/write routines from the blocking/deblocking source code of my CP/M 2.2 BIOS. The rest of the nonbanked BIOS was easy. The banked BIOS was considerably more difficult because, when debugging it, you can't see into the other bank to find out what is happening. Digital Research doesn't plan to offer CP/M Plus directly to end users because of the problems of implementing the BIOS. It will be up to hardware/software vendors to support BIOS modules for their products. I personally don't recommend writing a BIOS unless you have written one from the ground up or have had that level of systems-programming experience. ■

Please direct all requests for information about CP/M Plus to Digital Research.

Acknowledgments

The author wishes to thank Kathy Strutynski, Tom Mason, and Susan Raab at Digital Research for their assistance.

About the Author

Mark Dahmke is a consulting editor for BYTE.

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Quadram Corporation's MX700

A two-page video-display terminal

by Curtis P. Feigel

Quadram's MX700 is a microprocessor-based video terminal that uses sophisticated technology to provide features not available on other terminals. The unit's display is capable of showing the equivalent of two typewritten pages, side by side, on a single screen. The detached keyboard is a popular model that has its own microprocessor and incorporates software-controllable indicators and special-function keys. These features make the MX700 an excellent video terminal for use with word processors and spreadsheet programs (see photo 1).

Photo 1: *Quadram's MX700, a two-page video-display terminal.*

Why So Big?

As computer interfaces go, video terminals are the largest. They are capable of communicating more information at a time than any other peripheral. True, we don't normally think of video terminals as interfaces, but rather as output devices; perhaps this is an aspect of human/computer interaction that ought to be more carefully considered. In fact, if you think of a video terminal as a parallel port to the human brain, then the MX700 is close to ideal: it is just large enough to fill your main field of view when you're seated at the keyboard, but not so large as to be overwhelming.

This means that when you're editing text, for example, you can more easily see the relationship between the piece of text you're modifying and the context that surrounds it than you can on a display showing less text. The terminal takes over part of the editing burden by making organization obvious and allows you to devote your brain power to being creative.

Where the MX700 really shines is with software that employs windows. Using the terminal's ability to display two whole pages—each from a different file, if you like—is just like working at a desk. You can be typing on one page while referring to a whole page of notes.

It's unfortunate that the technology making this possible is expensive (list price of the unit is $2395), but an extremely high bandwidth video monitor is required, along with special electronics to drive it. And to display so much information as quickly as it does, the unit must employ memory that is 36 bits wide rather than the usual 8 bits.

The Display

The outstanding feature of the MX700—the whole reason for its existence—is its enormous screen, but the terminal has other screen attributes to recommend it. It has a combination of features rarely found in one unit and can display in a variety of formats and character sizes.

The video monitor, a 17-inch (diagonal measure) Ball Brothers unit, can display over half a million pixels (picture elements). Its screen area measures 13 inches wide by 10 inches high (by comparison, the screen area of a standard 12-inch video monitor is 9 inches by 6½ inches). In its densest format, the MX700 can show over 10,500

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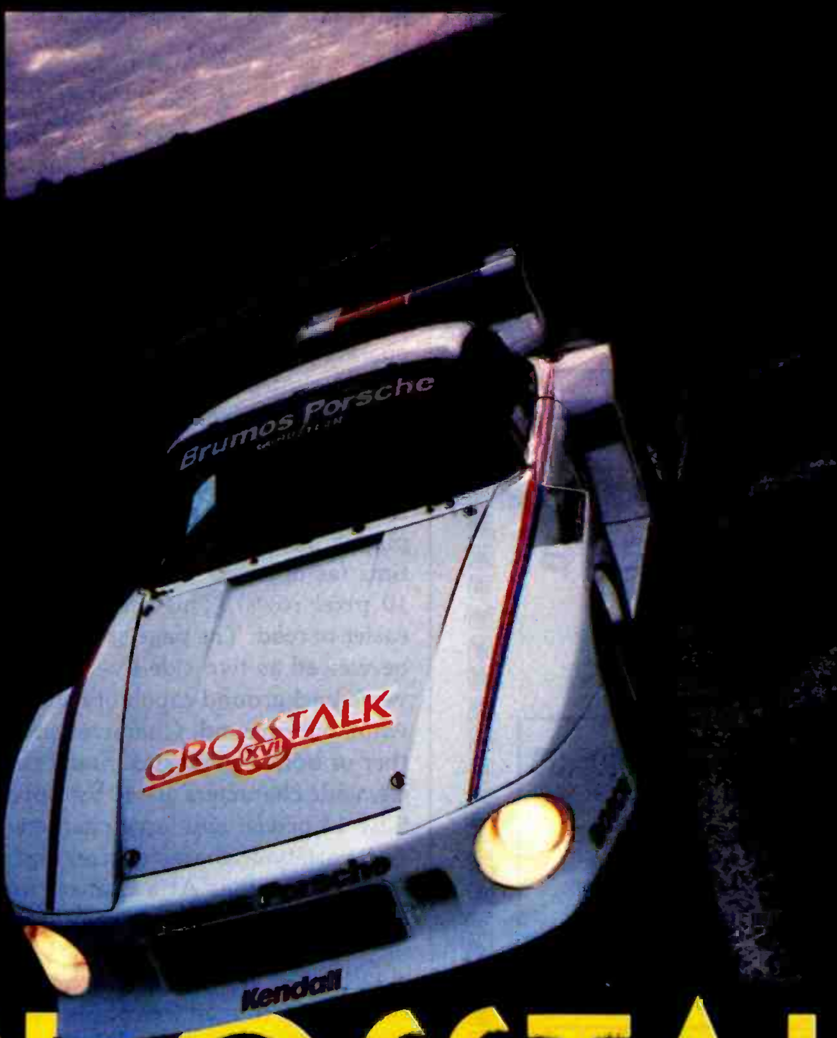

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At a Glance

Name
MX700

Manufacturer
Quadram Corporation
4357 Park Dr.
Norcross, GA 30093
(404) 923-6666

Price
$2395

Components
Separate keyboard unit and display unit, each with its own microprocessor

Keyboard:	3 inches high, 18 inches wide, 7 inches deep; 82 keys including a QWERTY typewriter layout section, a numeric keypad, and four special-function keys
Display:	16 inches high, 16 inches wide, 20 inches deep; can display the following formats: 66 lines by 160 small characters 2 pages of 66 lines by 78 small characters 66 lines by 80 wide characters 33 lines by 160 high characters 33 lines by 80 large characters

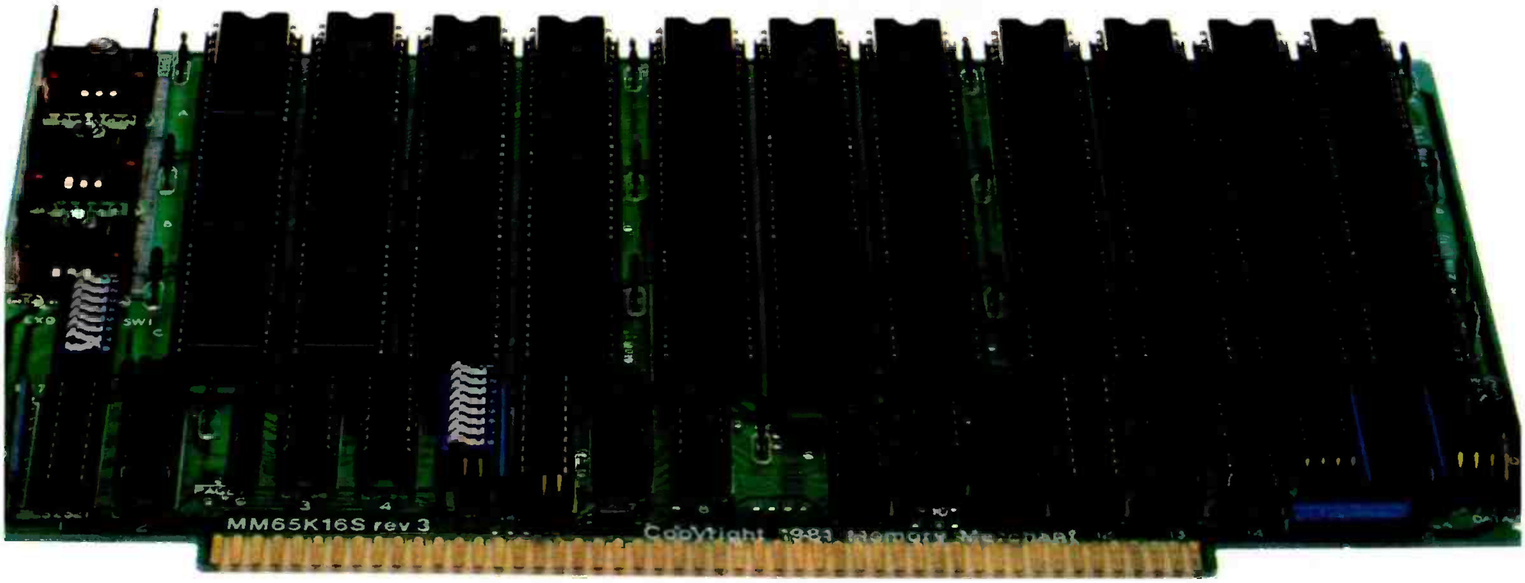
characters; a standard video terminal (24 lines of 80 characters) shows only 1920 characters, 18 percent of what the MX700 is capable of.

Besides the size of the screen, the MX700 has several display features not always found on video terminals. Smooth scroll is a sophisticated technique that allows displayed characters to be scrolled a single pixel row at a time (as opposed to scrolling by whole characters—8 or 10 pixel rows). This makes a quickly scrolling display easier to read. The page-split feature allows the display to be viewed as two side-by-side pages of text, and the reverse-background capability shows black characters on a white background. Character sizes may be doubled in either or both dimensions. Small characters are 5 by 7 pixels, wide characters are 10 by 7 pixels, high characters are 5 by 14 pixels, and large characters are 10 by 14 pixels.

A variety of character sizes and screen formats may be selected (see the "At a Glance" box for a complete list), but these combinations seem to be the most useful:

- 33 lines of 80 large characters: this produces a display that is easy to read (see photo 2a). It seems suitable for a classroom and would allow 8 to 10 people to view the same screen; it might also be used by individuals with poor eyesight.
- 66 lines of 160 small characters: the breadth of this format makes it ideal for displaying spreadsheet programs.
- 132 lines of 78 small characters: this format uses special hardware to split the screen vertically, producing a display equivalent to two typewritten pages placed side by side (the similarity to two sheets of paper can be heightened by configuring the terminal to show black

64K STATIC RAM MEMORY



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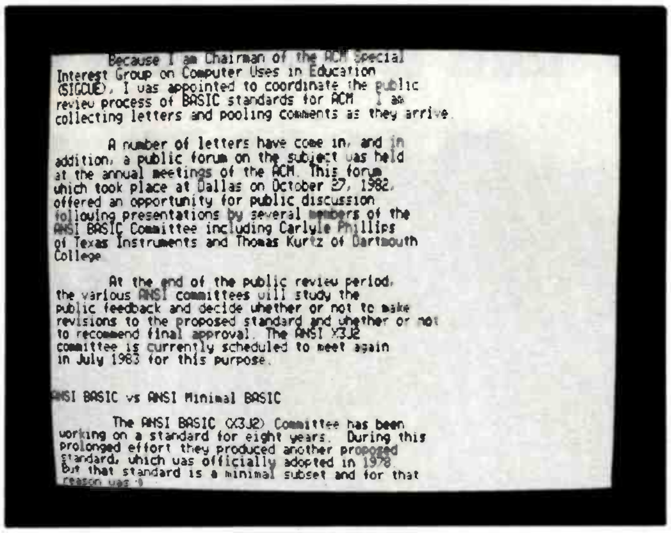


Because I am Chairman of the ACM Special Interest Group on Computer Uses in Education (SIGCUE), I was appointed to coordinate the public review process of BASIC standards for ACM. I am collecting letters and pooling comments as they arrive.

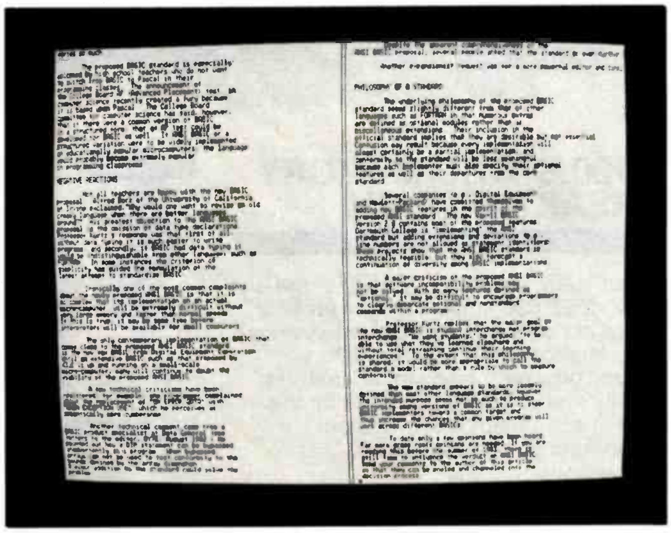
A number of letters have come in, and in addition, a public forum on the subject was held at the annual meetings of the ACM. This forum which took place at Dallas on October 27, 1982, offered an opportunity for public discussion following presentations by several members of the ANSI BASIC Committee including Carlyle Phillips of Texas Instruments and Thomas Kurtz of Dartmouth College.

At the end of the public review period, the various ANSI committees will study the public feedback and decide whether or not to make revisions to the proposed standard and whether or not to recommend final approval. The ANSI X3J2 committee is currently scheduled to meet again in July 1983 for this purpose.

ANSI BASIC vs ANSI Minimal BASIC

The ANSI BASIC (X3J2) Committee has been working on a standard for eight years. During this prolonged effort they produced another proposed standard, which was officially adopted in 1978. But that standard is a minimal subset and for that

(2a)



(2b)

Photo 2: *The range of the MX700's display capabilities. Photo 2a shows a full-screen display using large characters in black-on-white mode (there are 33 lines of 80 characters). Photo 2b shows a split screen of small characters in black-on-white mode (each of the two pages has 66 lines of 78 characters).*

characters against a white background; see photo 2b). In this mode, new lines of characters enter the display at the bottom of the right-hand page and scroll up; when lines scroll off the top of the right-hand page, they reappear at the bottom of the left-hand page and scroll up. This format is the obvious choice for word processing.

The Keyboard

The MX700's keyboard is a recent design manufactured by Key Tronic (of Spokane, Washington). It employs an Intel 8048 microprocessor to do away with much of the circuitry found in older designs. Its 82 keys are divided into a typewriter-like main section and a numeric keypad. The main section of the keyboard has two keys not commonly found on video terminals: Set-Up, which pro-

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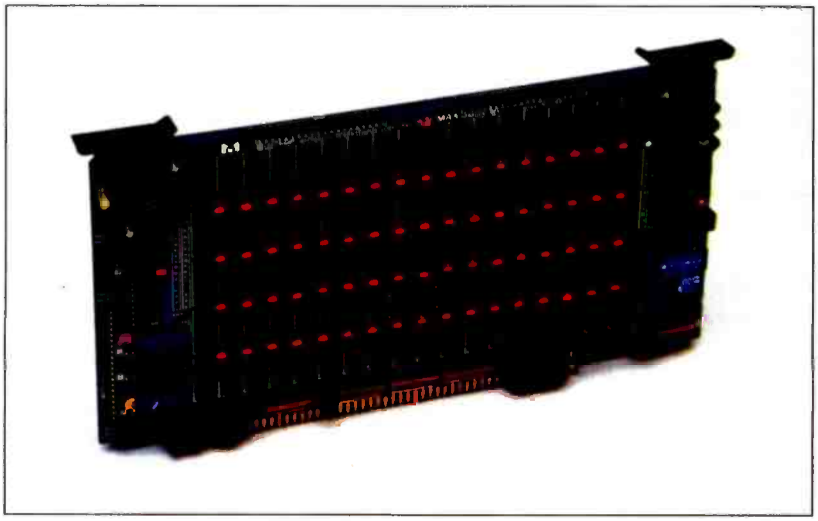

CHATSWORTH—June 30, 1983—Mike Pelkey, Macrotech International President, announced today that a special version of ***MAX*** is now running in Alpha Micro Systems.

This special version is available only through Soft Machines of Champaign, IL. (217) 351-7199. Howard Ogle of Soft Machines stated, "The new **AM-*MAX*1** runs full speed with all three Alpha S100 machines." Ogle also said, "The **AM-*MAX*1** is not only the most economical memory for Alpha, but the most versatile as well. The system is even faster with Soft Machines' 'GO FAST' disk cache utilities."

HOWARD OGLE

Bob Rubendunst of Soft Machines reports, "Every ***MAX*** is shipped with software that greatly simplifies implementation on bank switched systems. Also included are detailed installation instructions and diagnostic programs."

Dealer inquiries and orders should be directed to Bob at Soft Machines.

VIRTUAL DISK NOW NONVOLATILE

CHATSWORTH—June 30, 1983—Mike Pelkey announced today the release of the latest addition to the Macrotech product family. The **B-Board** is a multifunction system support board, for use with ***MAX*** and **128ST** memories. Used with the **128ST**, this combination creates a complete disk emulation, including nonvolatility. The **B-Board** features include battery backup, power fail monitor, and charging circuitry for on or off board batteries.

The **B-Board** functions also include a time-of-day clock, using a National Semi device for hassle free operation. It also gets early warning at power down, so the time-of-day can't suddenly get creative. An interrupt is available which can be used to turn the system on or off at a preset time.

On board ROM space accepts the users' EPROM based program storage. It can be configured to accept one or a pair of any EPROM type from 2716 to 27256, in 8 or 16 bit format. It supports a wake up jump option with full or shadowed phantom overlay.

The ERROR TRAP feature is designed to support the parity error detection feature of the ***MAX*** series dynamic memories. Any activity on the system's ERROR line causes the trap to record the extended address and data busses and 20 bits of bus status information. Up to 16 events can be trapped; the trap issues an interrupt when it's full.

The **B-Board** is a logical addition to the growing family of Macrotech International's no-compromise S100 boards for no-compromise users.

MAX Split Personality

BURBANK—June 30, 1983—"Many current operating systems permit ***MAX*** to double as both virtual disk and system memory," stated Dan West of Westcom Systems. As an example, an MP/M 2.1* system using ***MAX-M*** could be configured as a 512K system memory and a 512K Vdisk. A typical CP/M 3.0* configuration could be 256K of system memory and up to 768K Vdisk. CP/M 2.2* of course, only permits a 64K system memory, leaving the balance for a virtual disk. With ***MAX***, or the **128ST**, both functions can run simultaneously in a single memory board.

MACROTECH Moves

CHATSWORTH—June 30, 1983—Macrotech has moved to larger facilities located at 20630 Lassen St., Chatsworth, CA 91311. The new phone number is (213) 700-1501. "Due to a healthier marketplace and a phenomenal demand for the ***MAX*** series, larger facilities were necessary. This permits additional staffing, increased production, and customer support levels," said Mike Pelkey, President of Macrotech.

Virtual Disk for CP/M 86*

Dan West, Westcom Systems

BURBANK—June 30, 1983—Most of the CP/M 86* application programs available today fail to take advantage of the possible one megabyte address space. Virtual Disk for CP/M 86* will convert this unused space into RAM resident disk capacity for greatly improved disk access processing. The easily installed Virtual Disk 86 software module has been added to Macrotech's applications software available to owners of ***MAX*** series and **128ST** memory boards.

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*CP/M 2.2, CP/M 3.0, CP/M 86 and MP/M 2.1 are registered trademarks of Digital Research Inc.

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SET UP

S — SAVE	3 — PARITY (ODD, EVEN, NONE)	8 — WRAP (ON, OFF)
R — RECALL	4 — CHARSIZE (LARGE, SMALL, WIDE, HIGH)	9 — NLM (LINE FEED, NEW LINE)
0 — RESET	5 — PAGE (SPLIT, FULL)	X — HS MODE (XON/XOFF, DTR/CTS)
1 — LINE MODE (ONLINE, LOCAL)	6 — SCREEN (NORMAL, REVERSE)	
2 — BAUD RATE	7 — SCROLL (SMOOTH, JUMP)	

Table 1: *Arrangement of the menu produced when the MX700's Set-Up key is pressed. The terminal displays its present settings (optional settings are shown here in parentheses). You can change any setting simply by repeatedly pressing the proper item number or letter to cycle through all the possible settings for that item. For example, pressing the 6 key twice would change item number 6 from "screen normal" to "screen reverse" and back again. (The abbreviation NLM in item 9 stands for "new line mode." In item X, HS stands for "high speed"; XON and XOFF are ASCII [American National Standard Code for Information Interchange] control codes, and DTR and CTS are abbreviations for the RS-232C signals Data Terminal Ready and Clear to Send.)*

duces a menu for configuring the terminal's options, and No Scroll, which uses handshaking protocol to tell the host computer to stop sending data. Each printable character repeats when its key is held down for more than ½ second.

The keypad section has four special-function keys that each transmit a unique character sequence for your program to interpret. There are eight LEDs (light-emitting diodes) on the keyboard; three are used to indicate the conditions online, local, and locked, while the other five can be controlled by signals from the host computer.

The key tops are more deeply dished than usual, and the home-row keys are recessed slightly so that the keyboard has a sculpted look and is easy to type on, but there is almost no tactile feedback from a pressed key. All the keys are in the common positions except for the cursor-control keys, which are arranged in a horizontal line above the Return key and just outside the boundary of the main keyboard section. The easiest way to use them seems to be to jab the appropriate key with your right index finger while glancing down at the keyboard to make sure you get the right one.

Operation

Installing and using the terminal is a simple matter. There are no switches to set, no adjustments to make. Once the MX700 is connected to the host computer via an RS-232C cable, all you need do is press the Set-Up key to see a menu of the terminal's current settings (see table 1). Repeatedly pressing the X key or any of the numeral keys 0 through 9 will cause the corresponding menu item to display, one at a time, each of its possible settings.

Once the proper data rate, parity, and handshaking protocol are selected, the terminal is ready to use. Settings can be saved in battery-powered memory within the terminal and loaded automatically when the unit is turned on; they can also be altered by code sequences from the host computer. This provides a great amount of flexibility when used with word-processing software that is capable of handling function keys.

Conclusions

Using the MX700 terminal is a revelation. I found that the increased viewing area helps planning by giving a more complete, overall view than is possible with a normal video terminal. The time I would have otherwise spent scrolling back and forth between sections of text was instead spent more productively. In short, it makes word processors far easier to use because the terminal display does some of the work of "remembering" the arrangement of information. One side effect of having such a large screen in a serial video terminal is that it takes a lot of time to update; I would not consider using a data rate of less than 9600 bps (bits per second); 19,200 bps is preferable. (Item 2 of the Set-Up menu shown in table 1 gives the data-rate setting, here labeled "baud rate"; you can choose from 10 common rates between 75 and 19,200 bps.)

After using the MX700 with my favorite word processor for several months, going back to a standard terminal was a frustrating experience. Looking at a terminal that displayed only 24 lines of 80 columns was like wearing glasses with two thirds of one lens blocked and the other lens completely opaque. However, if you use the MX700 with a word processor that requires Control keys as commands, you may be irritated by the fact that the MX700's Control keys don't repeat when held down.

In this era of user friendliness, Quadram's MX700 comes close to the state of the art. Its large display makes it easy to maintain an overall view of word-processing and spreadsheet projects and provides a powerful interface for humans to communicate with and control computers. ■

About the Author
Curtis P. Feigel is a technical editor for BYTE.

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The 8088 Connection

Interfacing IBM PC BASIC to Machine-Language Programs

by Dan Rollins

Why would anyone bother with assembly language when BASIC is available? BASIC is a rich and flexible language; however, it has its drawbacks. You may want to add assembler code to a BASIC program in order to perform a function that is not part of the standard BASIC library. Or, even more likely, you may need something done faster than is possible with interpreted BASIC. You may also want to experiment with the microprocessor instruction set. In this article, I'll describe a method of adding 8088 machine-language subroutines to BASIC on the IBM Personal Computer (PC).

The technique involves five subtasks: creation and assembling of a source file, using the linker to create an executable (.EXE) file, converting the executable file to a memory-image file able to be loaded by the BASIC BLOAD command, bringing the file into protected memory, and testing and debugging the routine.

8088 Coding

To create a machine-language program, you'll need to master the instruction set of the 8088, the processor that drives the IBM PC. The 8088 is an exciting microprocessor. Its instruction set includes hardware multiply and divide (both 8- and 16-bit) operations, sign-extension for arithmetic operations between 8- and 16-bit operands, several memory-indexing modes, automatic looping instructions, string-handling op codes, and the ability to work in conjunction with other coprocessor chips such as the 8087 math chip.

Mastering the instruction set of the 8088 can be difficult even for an experienced programmer.

Branch and call instructions are all relative; you have to work hard to write a program that is *not* relocatable. And the 8088 can access as many as a million bytes of memory. But learning the 8088 can be difficult even for an experienced programmer. The concept of memory segments and the abundance of addressing modes and op codes are confusing.

To learn the 8088, or its work-alike brother the 8086, I recommend studying Stephen Morse's *The 8086 Primer* (Hayden Book Company Inc., 1980). Morse, the chip's architect, gives clear explanations and offers insights not found elsewhere. Other necessary texts include *The 8086 Book* by Russell Rector and George Alexy (Osborne/McGraw-Hill, 1980) and the IBM PC Macro Assembler manual. The fully documented IBM BIOS (basic input/output system) listing in the Technical Reference Manual will give you excellent examples of real-life 8088 code for study.

Once you have written an 8088 program, you will need an assembler to translate it. IBM offers two assemblers: The Macro Assembler requires 96K bytes of memory. It supports macro definitions and data-structure definitions and gives verbose error messages. The smaller version, ASM, will assemble only short programs but works in 64K bytes of memory. It does not support macroinstructions or data structures and gives only a

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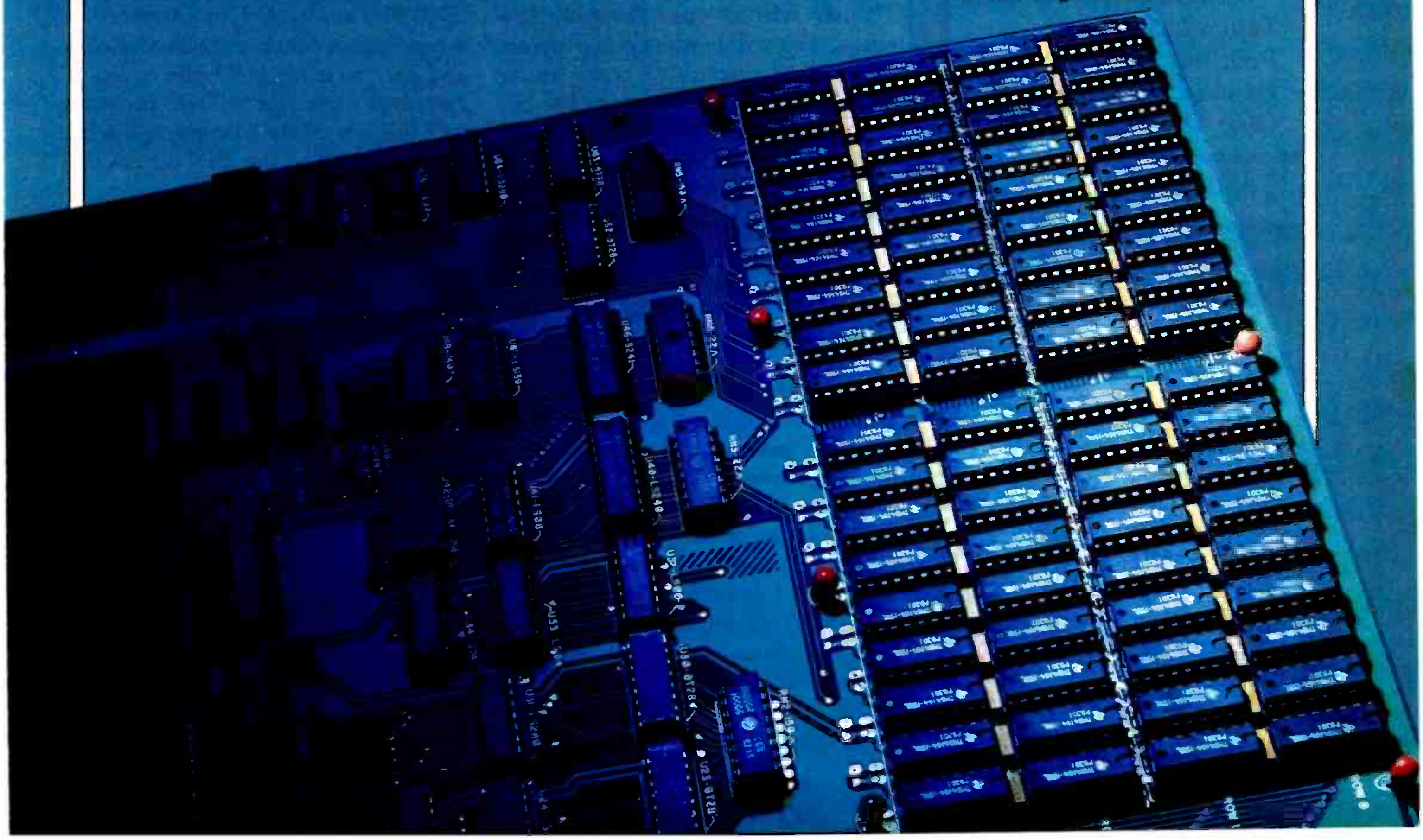


number when it encounters an error.

Here are some tips on coding 8088 programs for the IBM Macro Assembler: Tell the assembler what segments are active. Use the ASSUME pseudo-op to resolve ambiguity. Always specify the type of data and addresses to avoid ambiguity in instructions. For example, "MUL [BX]" is ambiguous; it can mean "multiply the AX register with the word pointed to by the BX register" or "multiply the AL register with the byte at that address." The instruction "MUL byte ptr [BX]" is clear; it means "multiply the byte at the address pointed to by BX with AL, leaving the result in AX."

Remember that labels refer to data and not addresses. For example, "ADD AX,MY_VARIABLE" means "add the 16-bit value of the data at the memory location specified by the label MY_VARIABLE (as offset from the DS segment register) to the AX register, leaving the result in AX." If you need to access the address of a variable, use the OFFSET operator, e.g., "MOV SI, offset MY_TABLE." Stick to one of the many methods provided by the assembler for specifying an indexed address to avoid confusion.

When writing your assembly language, you will need a good program editor. It is possible to write source code with EDLIN, the primitive line editor that comes with PC-DOS and other disk operating systems, but this will make assembly programming even more frustrating than necessary. I recommend Volkswriter by Lifetree Software Inc. for both word processing and program editing.

Special Considerations

The IBM BASIC manual describes a rather complicated method of loading an assembled program into BASIC memory and saving it with BASIC's BSAVE command. After some months of using this technique, I hit upon a simpler method: to create a file that I could load with BLOAD directly. This imposes requirements that you should keep in mind when writing a program for use with BASIC. A group of seven "header" bytes must precede the program (see listing 1). The BASIC BLOAD command uses these bytes to identify a module on which BLOAD can be used and to give it a default load address. Also the programs must fit within one memory segment. Finally, the assembler END pseudo-op must specify the address of the first header byte.

Linking the File

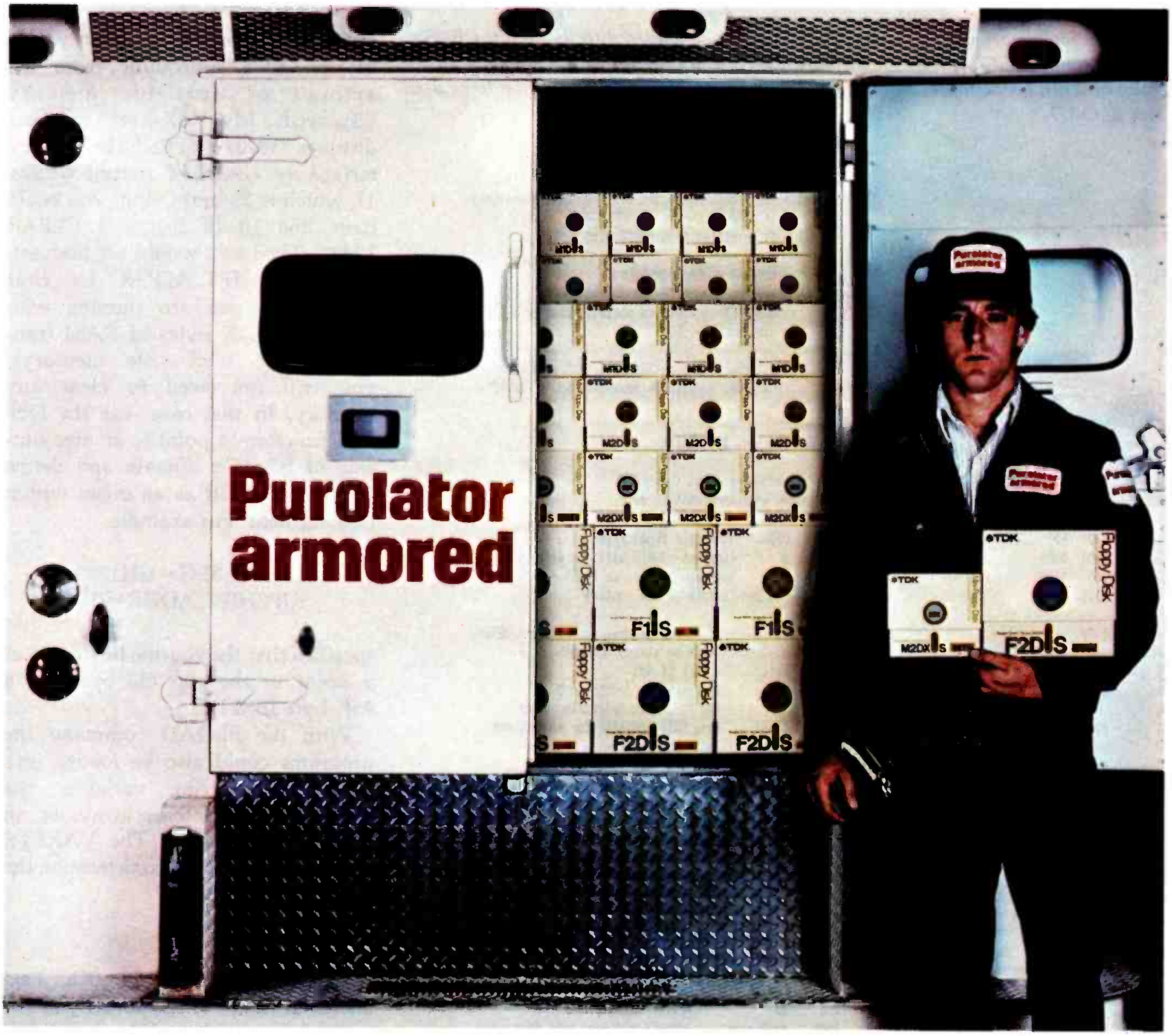
The assembler creates an object (.OBJ) file that must be converted to an executable (.EXE) file in which all external and internal references are resolved. The DOS linker program performs this task. Start the linker as described in the DOS manual, specifying only the file to be linked.

Because the file does not specify a stack segment, the linker will display "Warning: no stack segment" and indicate that an error occurred. This is exactly as expected—no cause for alarm. The .EXE files created by the linker contain a block of load and relocation data, which the DOS loader uses as it prepares to execute the program.

The BASIC program loader (BLOAD) does not require this information because it is designed for use with binary-image programs. These .EXE files are loaded into memory as a continuous block of code and data and must reside in 64K bytes or less of memory. Fortunately, DOS provides EXE2BIN, a utility to convert the file from the .EXE to the .BIN (or .COM) format.

The BASIC BLOAD command works only with programs in the non-relocatable format. Because my example .EXE file already contains the header bytes that BASIC needs, I can use this utility to create a module that can be loaded with BLOAD. Simply invoke EXE2BIN, specifying the name of the file that was just linked. BASIC will load the resulting .BIN file at the segment specified by the DEF SEG function (BASIC's default segment) at the offset specified in the BLOAD command.

Listing 2 shows a batch file that will assemble, link, convert, and test programs. This file saves a lot of typing and assures that no step is missed. If the batch file is invoked with two



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Listing 1: *Simple assembly-language programs can be loaded directly with the BASIC BLOAD command. This example demonstrates how a program must be preceded by a group of seven header bytes and must end with the END pseudo-op in order to be used with BLOAD.*

```
                                                page ,132
                                                title UPSHIFT - BASIC USR routine       Dan Rollins
                                                comment * This routine changes all lowercase characters
                                                          in a BASIC string to UPPERCASE.
                                                          It is called from BASIC via:

                                                          UPCASE$ = USRn(LOWCASE$)
                                                        where:
                                                          LOWCASE$ is a string variable name or a
                                                          string expression.

                                                          All characters in lowcase$ that were between
                                                          'a' and 'z' will be converted to 'A' to 'Z'.
                                                        *
0000                                    cseg    segment
                                                assume  CS:cseg, DS:nothing
                                        ;
                                        ;define the file header so that the BASIC
                                        ;BLOAD file loader will know what to do.
0000                                    header:
0000  FD                                        db      0FDH    ;indicate BLOAD file
0001  0000                                      dw      0       ;segment--BASIC will use default
0003  0000                                      dw      0       ;offset--specify in BLOAD command
0005  0023                                      dw      rtn_len ;length of the routine
                                        ;
0007                                    upshift proc    far         ;far proc insures intersegment RETurn
0007  3C 03                                     cmp     al,3        ;must be string argument
0009  75 1E                                     jne     exit        ; exit if not
000B  33 C9                                     xor     cx,cx       ;pre-set the length to 0
                                                                    ;BX => 3-byte descriptor block
000D  8B DA                                     mov     bx,dx       ;use base register for memory work
000F  8A 0F                                     mov     cl,[bx]     ;get the length
0011  80 F9 00                                  cmp     cl,0        ;is it a null string?
0014  74 13                                     je      exit        ; yes, exit. else, get ptr to characters
0016  8B 77 01                                  mov     si,[bx+1] ; SI => first character of string

=                                       char    equ     byte ptr [si] ;re-define a useful opcode
0019                                    each_char:
0019  80 3C 61                                  cmp     char,'a'        ;below 'a' ?
001C  72 08                                     jb      no_change       ; yes, leave it alone
001E  80 3C 7A                                  cmp     char,'z'        ;above 'z'?
0021  77 03                                     ja      no_change       ; yes, leave it

0023  80 24 5F                                  and     char,1011111B ;mask the lowercase bit
0026                                    no_change:
0026  46                                        inc     si              ;point to next character
0027  E2 F0                                     loop    each_char       ;dec CX and loop till done
0029                                    exit:
0029  CB                                        ret                     ;long RET to BASIC
002A                                    upshift endp
= 0023                                  rtn_len equ     $ - upshift     ;length of routine for header
002A                                    cseg    ends
                                                end     header          ;needed for .BIN file
```

Listing 2: *A batch file that aids in assembling, linking, conversion, and testing of programs.*

```
REM --- $ALB.BAT ---
REM Use to assemble, link, convert to
REM binary image, and test an .ASM file
REM that is to be interfaced with BASIC
REM
REM requires 1 argument : filename
REM optional argument   : list file
                          (LPT1:)
REM
    B:
    A:asm %1,,%2;
    A:link %1;
    A:exe2bin %1
    A:basic test
REM --- $ALB end of JCL ---
```

parameters ($ALB QPRINT,CON:), the assembler will generate a listing. Otherwise, the listing file will default to NUL (null).

The BASIC Interface

Once the file is in BLOAD format, it must be loaded into memory at an address protected from BASIC. In a 64K-byte IBM, this means that you must clear some memory using the BASIC CLEAR instruction as shown in listing 3. You can determine the amount to clear by looking at the screen when BASIC first starts up. Subtract the amount of memory used by the 8088 subroutine from the amount of available memory displayed. My 64K-byte machine displays "38907 BYTES FREE". To interface the UPSHIFT routine (listing 1), which is 35 bytes long, you could have line 10 of listing 3 CLEAR 38871. Then you would set the variable UPSHIFT.ADDR to that number. If you are running with more than 64K bytes of RAM (random-access, read/write memory), you will not need to clear any memory. In that case, use the DEF SEG function to point to an area outside of BASIC's domain and define UPSHIFT.ADDR as an offset within that segment. For example:

```
10 DEF SEG=&H1700
:UPSHIFT.ADDR=0
```

specifies that the routine be loaded at a point in the top 4K bytes of a 96K-byte IBM PC.

With the BLOAD command the programs could also be loaded into the BASIC string variable, the elements of an integer array, or an unused input buffer. The VARPTR function can be used to determine the offset for the BLOAD.

Debugging

Placing an extra byte, 0CC hexadecimal (INT 3), temporarily at the start of executable code is a handy aid to debugging the 8088 program when used in conjunction with DEBUG, the IBM machine-language monitor. To debug a program, write a BASIC test program (listing 4) then type DEBUG BASIC.COM and use DEBUG's G command to execute BASIC. Run the BASIC testing program to load and invoke your 8088 subroutine. When control is passed to the routine, the first byte will act as a DEBUG breakpoint. You'll be able to Unassemble, Dump, and Trace (single-step through) the subroutine.

Change the INT 3 to a NOP (90 hexadecimal) with the E (edit) command. As you trace the execution, watch to make certain that the parameters are being used in the right order and that the stack is cleared and the segment registers are restored

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Listing 3: *Program to test the UPSHIFT program in listing 1.*

```
0 '**  UPTEST.BAS    Dan Rollins  12/28/82
1 '**  tests the UPSHIFT USR routine
2 '**
10 CLEAR,30000 :UPSHIFT.ADDR=30000
20 BLOAD"b:upshift.bin",UPSHIFT.ADDR
30 DEF USR0=UPSHIFT.ADDR
40 CLS
50 INPUT "enter some lowercase characters";A$
60 PRINT USR0(A$)
70 A$="This program line is lowercase."
80 UU$=USR0(A$)
90 PRINT :LIST   '** show that line 70 has been altered
```

Listing 4: *A BASIC test program to load and invoke UPSHIFT.*

```
1 '** QPTEST.BAS     Dan Rollins    12/20/82
3 '** Tests the QPRINT 8088 subroutine
4 '** and compares time with BASIC.
5 '**
10 CLEAR,30000                  '** protect memory above 30000
20 QPRINT=30000                 '** define load, call address
30 BLOAD"B:QPRINT.BIN",QPRINT   '** load routine into memory
40 T1$=TIME$                    '** get starting time
50 GOSUB 1000                   '** test the routine
60 CLS: PRINT TIME$ :PRINT T1$  '** compare start & end times
70 END
990 '** subroutine fills the screen.  Use line 1050
991 '** to compare BASIC's speed.
992 '**
1000 CLM%=1 :CLS :KEY OFF
1010 FOR J%=32 TO 100
1020  A$=STRING$(80,J%)
1030  FOR ROW%=1 TO 24
1040   CALL QPRINT(A$,ROW%,CLM%)
1050  'LOCATE ROW%,CLM% :PRINT A$;
1060  NEXT
1070 NEXT
1080 RETURN
```

upon exit. Incidentally, you may trace execution right into ROM (read-only memory) BASIC and glean some valuable information as to how BASIC operates.

User Service Routines

Once a program has been loaded, it may be invoked by either a User Service Routine (USR) function or a call statement. BASIC treats the USR function just like an ASC (*string expression*), SIN (*numeric expression*), or any other one-argument function. It evaluates the expression between the parentheses and then takes the indicated action. The function gives the programmer some flexibility in how the routine is invoked. For example:

PRINT USR0(A$)

LSET B$=USR0 (A$)

B$=MID$(USR0(A$),12,2)

A$=USR0(LAST.NAME$ + ", " + FIRST.NAME$)

IF USR0(INPUT$(1)) ="Y"THEN . . .

are all valid ways to invoke the UPSHIFT function. The drawback of using the USR function is that only one value may be passed to the 8088 subroutine.

Before BASIC hands control to your code, it places the address of the evaluated argument in the DX register and a variable type-code in the AL register. Listing 1 shows how to manipulate a value passed to the USR subroutine. Notice in line 27 that the AL register is compared to 3, the type-code for string-variable arguments. If the variable is not a string, then the routine is exited with no action taken.

When UPSHIFT is sure it's working with a string, it must determine the string's length and location. Line 31 places the value in DX into the base register BX and uses the parameter as a pointer to a string descriptor block. The first byte of this descriptor block

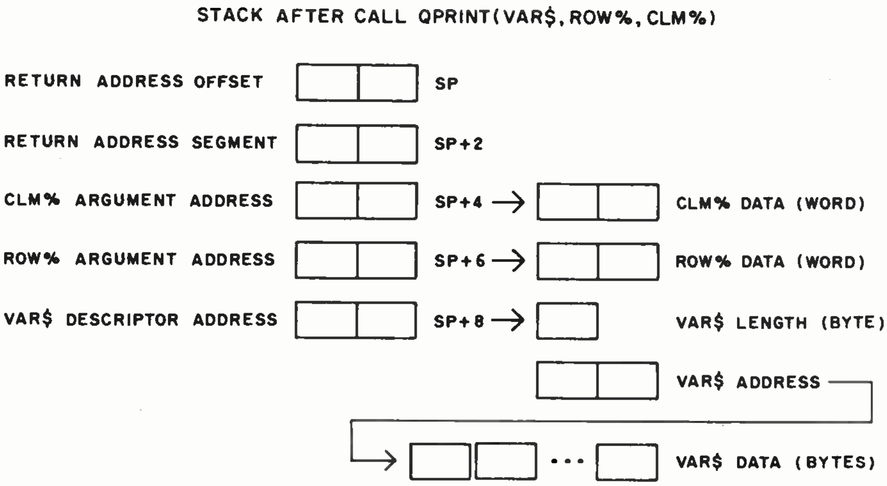

Figure 1: *A stack model showing how BASIC passes 2-byte addresses to a called routine.*

defines the length of the string as between 0 and 255 inclusive. If the value is 0 (a null string was passed as the argument), the routine is aborted and no action is taken. Otherwise this length is placed in the CX register and used as a counter. The second and third bytes of the string descriptor block identify the location of the characters of the string data. Line 35 points SI, an index register, at the first character of the string. The loop beginning at line 38 and ending at line 47 checks each character to see if it is lowercase and masks the lowercase bit if so.

Because line 26 defined UPSHIFT as a FAR procedure, the RET (return) at line 49 has been assembled as an intersegment return, as required by BASIC. Notice that UPSHIFT makes no effort to save and restore the registers it uses. BASIC only gets confused when the routine alters any of the segment registers or the stack pointer.

Listing 3 illustrates an interesting facet of the BASIC/8088 connection. When a machine-code subroutine alters a BASIC string, it may *alter program text*. If the string is a literal in a program line, the string descriptor block will point to that program line. The same is true for strings that have been read from DATA lines. If such an alteration occurs and you later save the BASIC program, the changes will be permanent.

The CALL Statement

The CALL statement is less flexible in the way it may be invoked but will pass more than one argument to an 8088 subroutine. It also may be used to return more than one value to the calling BASIC program.

Appendix C of the BASIC manual goes into some detail as to how to access an argument passed to a called routine (figure 1). BASIC passes a 2-byte address to the routine for each variable in the argument list. BASIC pushes these addresses onto the stack in the order in which they occur in the CALL statement. The address of the last variable in the list will be closest to the stack pointer when the routine takes control.

After BASIC pushes these addresses on the stack, it makes a FAR call to the offset (within the currently defined segment) specified in the CALL command. Because a FAR call saves both the CS (code segment) and IP (instruction pointer) register values on the stack, the argument addresses will be offset from the SP (stack pointer) by exactly 4 bytes.

Page C-11 of the BASIC manual gives a formula for calculating the locations of the argument addresses. The formula assumes that you will first push BP (base pointer) onto the stack, thereby making the closest argument address 6 bytes away from the stack pointer. The argument addresses may then be accessed as pointers to the actual data by determining their position in the stack and using BP as an index register to set the address into BX. If the variable is numeric, BX points to the numeric data. If the variable is a string, then BX points to the string descriptor block, and the data there will point to the actual characters of the string.

After diligent research and experimentation, I could find no reason to push BP before using it to reference the parameters. The manual clearly states that only segment registers need to be saved. You can use other methods to access the arguments. The routine could, for example, just move the addresses from the stack into the available registers through the POP function—as long as the return address (the top 4 bytes on the stack) is saved, then restored upon exit.

Quick PRINT

IBM PC BASIC is disappointingly slow. It is obvious that much of the code is a direct translation from an 8080 version of Microsoft BASIC. Perhaps the most distressing point is the sluggish PRINT command. It takes nearly 4 seconds to fill the 80 by 25 screen with characters.

Mother Necessity prompted me to write an 8088 subroutine to shorten the delay. The results were astounding. QPRINT (in listing 5) will display an 80-character line in the blink of an eye and fill the screen in one-tenth the time required by BASIC. The program avoids the character-by-character processing that typifies the BASIC PRINT command. It displays the entire string in a tight loop. Also, because QPRINT ignores the attribute byte that normally accompanies a printed character, it makes half as many screen memory accesses. Functionally, QPRINT combines the LOCATE command with PRINT, thereby saving more BASIC overhead.

A call to QPRINT displays characters of an argument string starting at the horizontal and vertical screen coordinates specified in two integer arguments. It does not update the cursor position or specify any color for the characters printed. The characters take on the color, blink, and underline attributes of whatever characters were previously there. If a string will not fit on one screen line, it will wrap around to the next.

The QPRINT routine also includes

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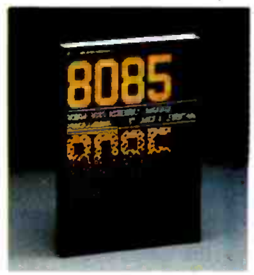

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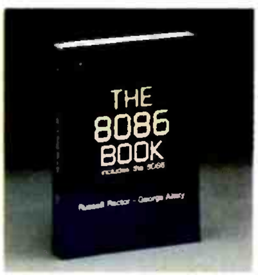

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the logic for determining which type of display card is being used (color or monochrome). The row and column arguments are correct for either 40- or 80-column displays.

The comments in listing 5 explain the inner workings of the program. However, two points need clarification. Lines 27 to 34 define a segment that is outside of the program segment. No code is generated for this definition; it is used only to set up the labels used in lines 68, 71, 75, and 82. This does not violate EXE2BIN's

Listing 5: *This streamlined output routine displays strings on the video monitor 10 times faster than BASIC.*

```
1                              page ,132
2                              title QPRINT - 8088 routine CALLed from BASIC      Dan Rollins
3
4                              comment * This routine prints a string to the video display at
5                                        10 times the speed of BASIC.  Works for color or
6                                        monochrome in 80 or 40 column TEXT modes (no graphics).
7                                        Characters are displayed with the existing color,
8                                        blink, and underline attributes.
9
10                                   Called from BASIC via:
11
12                                     CALL QPRINT(VAR$,ROW%,CLM%)
13
14                                   Where:
15
16                                     CLM% is an integer variable name (1-80)
17                                     ROW% is an integer variable name (1-25)
18                                     VAR$ is a string variable name.
19
20                                     VAR$ is displayed beginning at position CLM% of line
21                                         ROW%. If too long, it will wrap around to
22                                         the next line.
23
24                                   note: Color card pages 1-7 may be accessed by setting
25                                         ROW% above 25.
26                                   *
27  0000                   bios_data segment at 40H  ;set up labels to determine
28  0010                             org    10H      ; color or monochrome card
29  0010                   equip_flag label  word
30  004A                             org    4AH      ; 40 or 80 column display
31  004A                   crt_cols  label  word
32  0063                             org    63H
33  0063                   addr_6845 label  word     ; points to video card ports
34  0063                   bios_data ends
35
36  0000                   cseg    segment
37                                 assume  CS:cseg, DS:nothing, ES:nothing
38                         ;
39                         ;Define the file header so that the BASIC
40                         ;BLOAD file loader will know what to do.
41                         ; --- these bytes are not executed ---
42                         ;
43  0000                   header:
44  0000  FD                       db      0FDH    ;indicate BLOAD file
45  0001  0000                     dw      0       ;segment--BASIC will use default
46  0003  0000                     dw      0       ;offset--specify in BLOAD command
47  0005  0062                     dw      rtn_len ;length of the routine
48                                 page
49  0007                   qprint  proc    far
50  0007  06                       push    es         ;must save for BASIC
51  0008  8B EC                    mov     bp,sp      ;point to arguments on stack
52
53  000A  8B 5E 06                 mov     bx,[bp+6]  ;get addr of CLM% storage
54  000D  8B 3F                    mov     di,[bx]    ; get the column value
55  000F  4F                       dec     di         ; adjust for LOCATE format
56
57  0010  8B 5E 08                 mov     bx,[bp+8]  ;get addr of ROW% storage
58  0013  8B 07                    mov     ax,[bx]    ; get the screen line value
59  0015  48                       dec     ax         ; adjust for LOCATE format
60
61  0016  8B 5E 0A                 mov     bx,[bp+10] ;get ptr to string descriptor
62  0019  32 ED                    xor     ch,ch      ; zero the high byte
63  001B  8A 0F                    mov     cl,[bx]    ;get length of string
64  001D  80 F9 00                 cmp     cl,0       ;null string?
65  0020  74 32                    je      exit       ; if so, do nothing. Else,
66  0022  8B 77 01                 mov     si,[bx+1]  ; SI => 1st character of VAR$
67                         ;
68  0025  BB ---- R                mov     bx,bios_data  ;get ready to determine card type
69  0028  8E C3                    mov     es,bx         ; and number of columns
```

Listing 5 continued on page 410

Listing 5 continued:

```
70
71   002A  26: F7 26 004A R        mul     es:crt_cols ;AX = CLMZ * words per line
72   002F  03 F8                   add     di,ax       ;DI = words from start of screen
73   0031  D1 E7                   shl     di,1        ; adjust for attribute bytes
74
75   0033  26: 8B 16 0063 R        mov     dx,es:addr_6845 ;point to 6845 base port
76   0038  83 C2 06                add     dx,6            ;point to status port
77
78                         ; CX has the count of characters to write,
79                         ; SI (Source Index) points to the string data,
80                         ; DI (Destination Index) points to a screen position,
81   003B  B8 B800                 mov     ax,0B800H       ;default to color card
82   003E  26: 8B 1E 0010 R        mov     bx,es:equip_flag
83   0043  81 E3 0030              and     bx,30H
84   0047  83 FB 30                cmp     bx,30H          ;is it monochrome?
85   004A  75 03                   jne     card_ok         ; no, go
86   004C  B8 B000                 mov     ax,0B000H       ; yes, set for monochrome
87   004F                  card_ok:
88   004F  8E C0                   mov     es,ax           ; point ES to video
89
90                         ; DS (Data Segment) points to BASIC variables area
91                         ; ES (Extra Segment) points to video card memory
92                         ; Now display VAR$ on the screen.
93
94   0051  E8 005B R               call    print_string
95   0054                  exit:
96   0054  07                      pop     es              ;restore segment register
97   0055  CA 0006                 ret     6               ;intersegment return,
98                                                         ; clearing stack of 3 args
99   0058                  gprint  endp
100                                page
101                        ;this procedure displays a string of characters
102                        ;expects:
103                        ;         DS:SI => first character of string
104                        ;         ES:DI => screen memory to display it
105                        ;         CX    =  number of characters to display
106                        ;         DX    => status port of video card
107
108  0058                  print_string    proc    near
109
110                        ;----------- wait for horizontal retrace
111  0058                  test_low:
112  0058  EC                      in      al,dx           ;get status
113  0059  A8 01                   test    al,1            ; is it low?
114  005B  75 FB                   jnz     test_low        ; no, keep checking
115  005D  FA                      cli                     ;turn off interrupts
116  005E                  test_hi:
117  005E  EC                      in      al,dx           ;get status
118  005F  A8 01                   test    al,1            ; is it high?
119  0061  74 FB                   jz      test_hi         ; no, keep checking
120                        ;---------- okay to write to screen now (no 'hash')
121
122  0063  A4                      movsb       ;[DS:SI] -> [ES:DI], DI++, SI++, CX--
123
124  0064  47                      inc     di              ;skip the attribute byte
125  0065  E2 F1                   loop    test_low        ;do till end of string
126
127  0067  FB                      sti                     ;turn interrupts back on
128  0068  C3                      ret                     ;back to gprint proc
129  0069                  print_string endp
130
131        = 0062          rtn_len equ     $ - gprint      ;define length for BLOAD header
132  0069                  cseg    ends
133                                end     header  ;needed for .BIN file conversion
```

rule of having only one segment. Because the ES (extra segment) register will be destroyed by the program, it is saved at the beginning. The PUSH in line 50 means that the argument addresses must be calculated keeping this in mind.

The RET op code in line 97 is one of the refreshing innovations of the 8088 microprocessor. When executed, the 4-byte address on the top of the stack is loaded into the CS and IP registers, but before execution resumes at the return address, 6 is added to the stack pointer. This effectively pops the argument addresses off the stack, clearing it. The constant specified in this RET instruction must be 2 times the number of arguments passed from BASIC.

Lines 110 through 120 are a late addition to my original version. This

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code is copied verbatim from the ROM BIOS listing in the Technical Reference Manual. It ensures that screen memory is modified only while it is not being examined by the display hardware, thereby avoiding irritating "hash" streaks that result from modifying memory while it is being displayed on the screen. The result is a fractional lost in speed and a substantial gain in usability.

Compiler BASIC

The IBM BASIC compiler may be the answer to some BASIC speed problems, but it does not solve the PRINT problem. A compiled version of the timing test in listing 4 performed only 20 percent faster than the interpreted BASIC version. Using the call to QPRINT still speeds the test up by a factor of eight. Thus, there are good reasons to interface assembler code to compiled BASIC.

Several changes need to be made to 8088 subroutines that are used with compiled BASIC. The USR command is all but useless. It does not pass an argument to the called routine. However, there are two forms of the CALL statement available in the compiler.

CALL SUBRTNAME
[(VARIABLE[,*variable*] . . .)]

is a call to an external .OBJ module. The module *subrtname* must have been assembled previously with a PUBLIC statement identifying the indicated procedure. It must be linked with the .OBJ module created by the compiler. The header bytes used in listing 5 must *not* be included in this type of module.

CALL ABSOLUTE ([VARIABLE
[,*variable*] . . .,] INTVAR

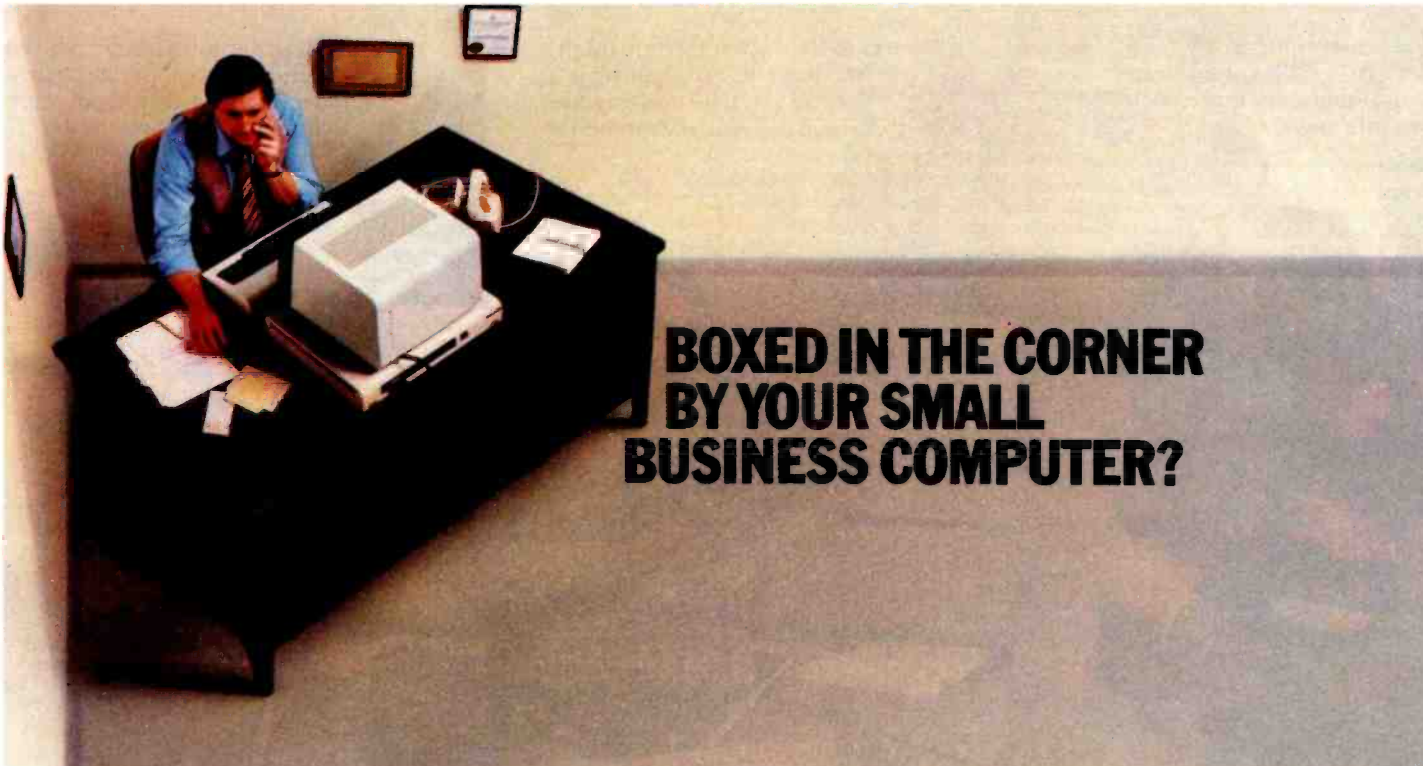
calls a routine in memory in the currently defined segment at an offset specified by INTVAR. This form of the CALL statement assumes that an 8088 subroutine was loaded with BLOAD or inserted with the POKE command into memory beforehand.

The arguments of either CALL statement are accessed exactly as described for interpreter BASIC. The lone major difference is in accessing string data. Compiler strings can be as long as 32767 bytes. Therefore, the string descriptor block for compiled BASIC is 4 bytes instead of 3. The first 2 bytes specify the length of the string, and the next 2 point to the address of the first character of the string.

Conclusions

Since the 8088/8086 processor has been blessed by IBM, it is bound to be around a long time. By interfacing BASIC with 8088 machine code, it is possible to create useful extensions to the BASIC language and realize enormous gains in execution speed. Learning how to code with the IBM macro assembler is both fruitful and enjoyable. ■

About the Author
Dan Rollins (Unique Software, 134 Olive, Suite #C, Glendale, CA 91206) is a freelance programmer and technical writer. He is currently working on IBM-PC: 8088 Macro Assembler Programming *to be published by Macmillan in 1984.*



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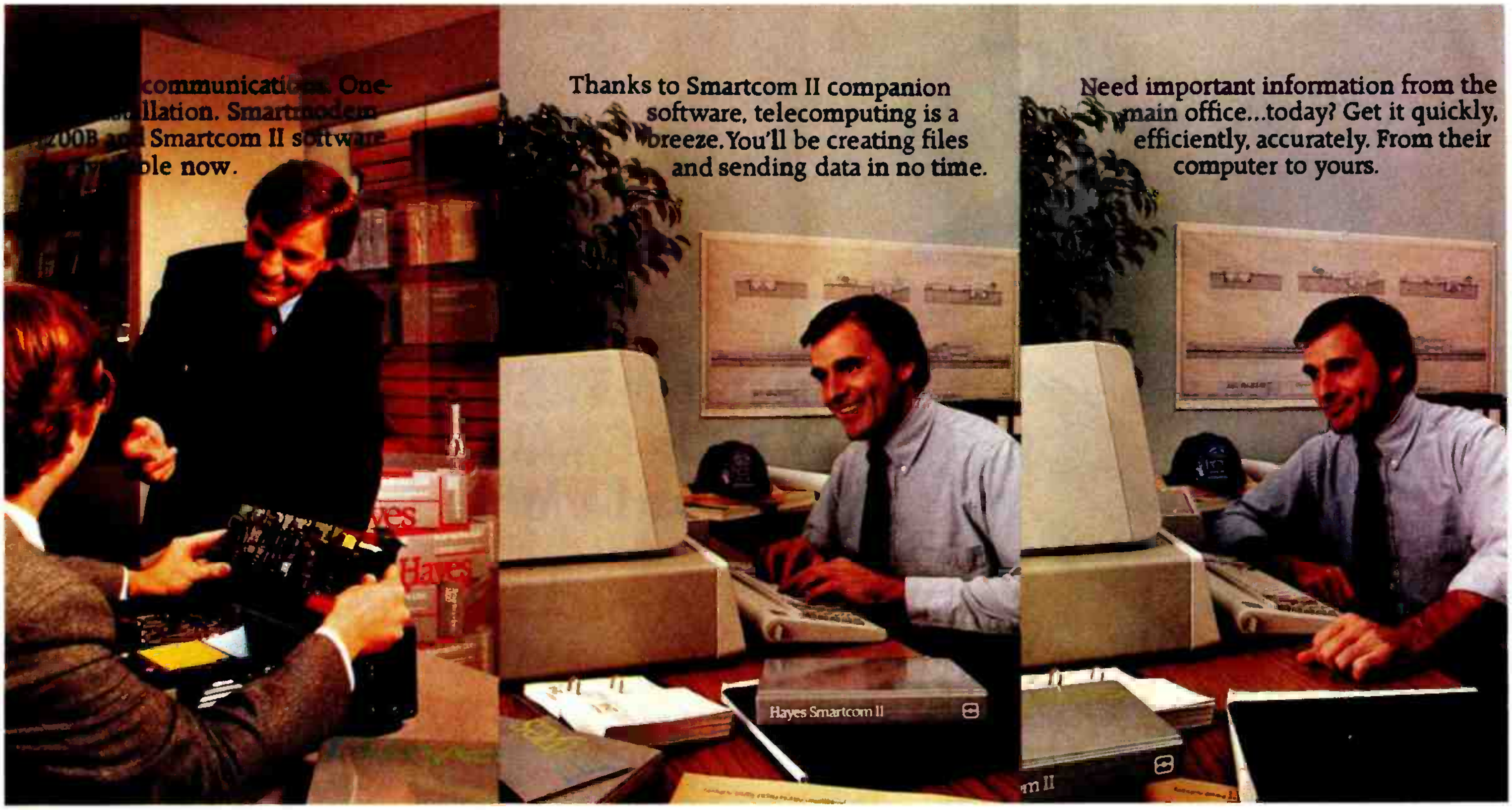

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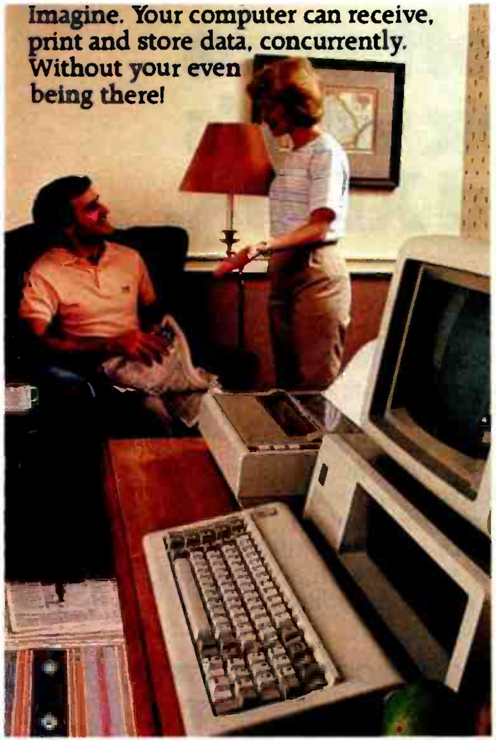

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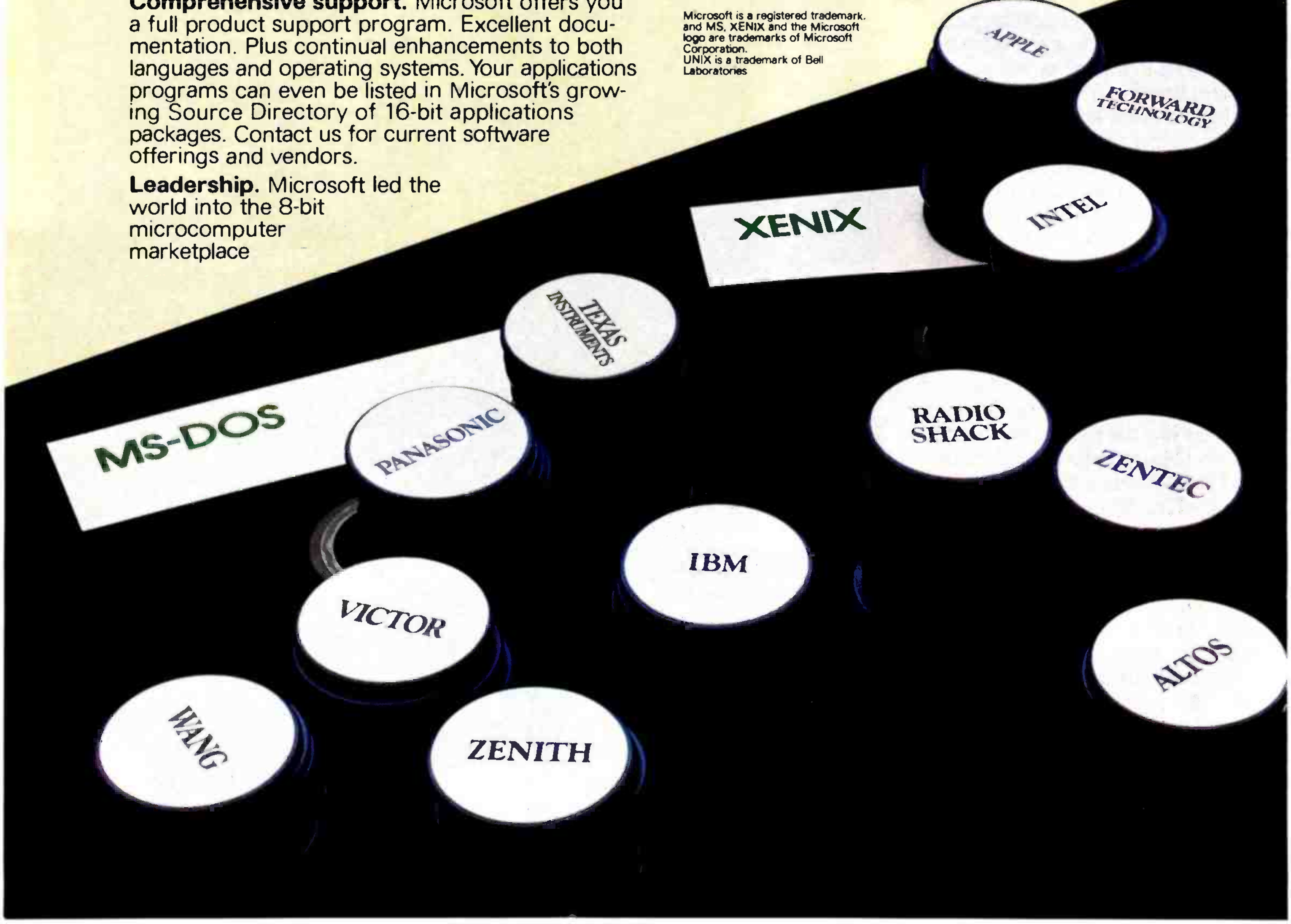

Squeezing Memory from the Apple with Pascal

Using Apple Pascal's segmentation facilities and a few other techniques, you can write bigger programs than you might have thought possible.

by Jill David

Segmentation is one memory-management technique used to implement virtual memory, itself a concept that has only recently entered the world of microcomputers. With virtual memory, disk storage is employed in a manner that creates the illusion that more main memory is available than actually exists.

Virtual memory was invented by mainframe computer designers, but some of the more sophisticated microcomputer operating systems, such as Apple/UCSD Pascal, can perform segmentation and are therefore well suited to implement virtual memory. Proper use of UCSD Pascal's virtual memory and other resident facilities allows you to write much larger programs than would otherwise be possible.

With segmentation, a program is broken up into chunks (segments) of which only a few are actually in memory at a given time. If a segment not in memory (nonresident) is called (demanded), it is loaded into memory from disk. This technique is possible because all of a program's instructions cannot be executed simultaneously, so there is no need to have an entire program in memory at once. Segmentation and other memory-management techniques, such as paging, allow maximum exploitation of virtual memory. Importantly, the process is efficient enough so that the time delay of swapping program portions in and out of memory is barely noticeable to the user.

Among its other benefits, segmentation induces better program organization.

Besides allowing you to write larger programs, segmentation has other advantages. It favors the logical grouping of related routines (procedures or functions) in one unit, called a segment, thus encouraging you to write well-organized code and to keep track of the relationships among the routines and the frequency with which they call each other.

Segmentation also allows more efficient memory use by requiring a program segment to be in memory only when it is called. As a result, routines used infrequently—or only once—do not take up memory space when not being used. Initialization routines or procedures, which are often quite large, are prime candidates for segmenting; they are executed once at the start of a program and usually are not needed again.

Segmentation does have some disadvantages, such as a time/space trade-off—a program segment must be loaded into memory from disk when it is called, causing a slight delay in program execution. Under the older version of Apple/UCSD Pascal, the time delay was intolerable; in the newer version (1.1) disk accessing is considerably faster, with the delay while loading a new segment taking only a few seconds.

Further, the operating system must be more complex to keep track of which segments are where, but this complexity is transparent to the user, and the capability for segmentation exists whether you choose to use it or not.

With the standard version of the

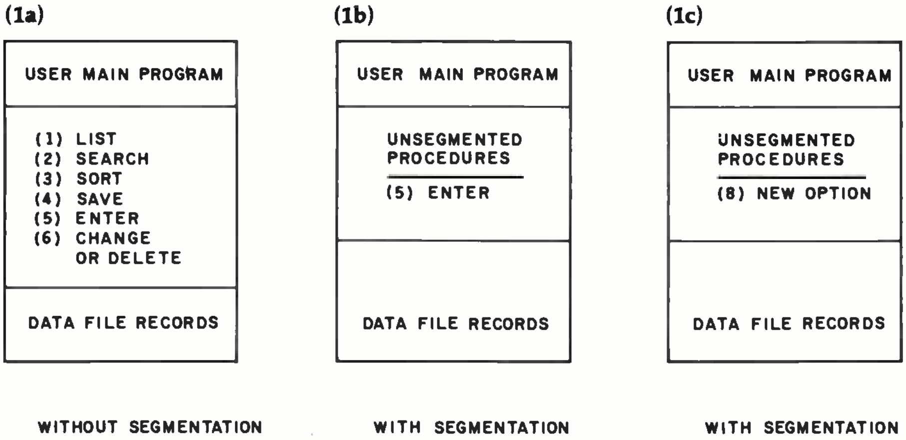

Figure 1: *With segmentation, not only can more records be included, but the application program can be expanded to include more capabilities.*

Apple II and IIe, you are limited to 16 segments per program (this figure is not exactly correct but I'll explain this later). Because a segment is designed for a large section of a program, rather than for a single small procedure, this 16-segment limit is hardly a handicap for Apple Pascal programs if segmentation is used properly. In fact, the entire operating system of UCSD Pascal never exceeded this limit even though it used segmentation extensively in many of its programs, such as the Compiler.

(The filer was intentionally not segmented so that you could remove the system disk on which the filer resides, yet maintain access to the filer commands. If the filer had been segmented, that system disk would have had to remain in a drive so the filer could be called into memory when the filer's commands were needed. Similarly, the code file for segmented programs must remain online on a disk drive unit throughout execution.)

Are you convinced in favor of segmentation yet? If not, consider how it would affect a hypothetical database application with a menu of the following options:

Select:
1. list records
2. search for record
3. sort file
4. save file
5. enter a new record
6. change or delete a record
7. quit

Figure 1 shows a bird's-eye view of memory at a point during execution of this program. Figure 1a shows memory without segmentation; figure 1b shows what memory might look like if segmentation were used.

As the figure illustrates, segmentation makes more room available for records of the hypothetical database file.

To create segment procedures and segment functions, you simply place the keyword SEGMENT in front of the keyword PROCEDURE or FUNCTION.

Figures 1b and 1c indicate a space for unsegmented procedures/functions—frequently used procedures that will remain in memory at all times, such as a procedure to print one record (on screen or printer) that may be called from the ENTER, CHANGE or DELETE, LIST, and SEARCH routines. In addition to increased space for data structures, expanding the program to include more options may not be possible without segmentation, unless the number of database records is decreased (figures 1a and 1c).

What happens to a segment when its execution terminates? The calling routine continues executing, pretending that the old segment in memory doesn't exist; or if another segment procedure is called, then the new one is loaded into memory from disk, perhaps overwriting the old one. (For more information about program stack management during execution, see the *Apple Pascal Operating System Reference Manual* [Cupertino, CA: Apple Computer Inc., 1980], pages 248-264.)

Three Varieties

There are three kinds of segments: (1) your main program itself is a segment; (2) segment procedures and segment functions are segments; and (3) regular units are segments. The first category is self-explanatory. Segment procedures and segment functions are simply procedures and functions that you have specified as separate segments by adding the keyword SEGMENT in front of the keyword PROCEDURE or FUNCTION (as in the statement SEGMENT PROCEDURE SEARCH(ITEM: DATATYPE); or SEGMENT FUNCTION SEARCH(ITEM: DATATYPE):BOOLEAN;).

Only a few rules need to be followed when using segment procedures or functions:

Rule 1: Segment procedures (or functions) must be the first definitions after the variable declaration (VAR) section of the main program. Because some segment procedures (or functions) may call procedures or functions that are unsegmented (i.e., in memory all the time), FORWARD references must be declared for these unsegmented procedures after the VAR section. Otherwise the Compiler will mark the procedure calls within the segmented procedure as undeclared identifiers and issue a compile-time error.

The skeleton program in listing 1 includes a FORWARD reference. The parameters of the procedure (or function) are declared in the FORWARD reference, but they are not repeated in the actual definition of the procedure, which appears after all segment-procedure definitions. FORWARD references may be used in any program, segmented or unsegmented.

Listing 1: *If using segment procedures or functions, other procedures and functions must be declared with FORWARD references to avoid errors at compile-time.*

```
  PROGRAM DATABASE;
  USES APPLESTUFF, TURTLEGRAPHICS;

  TYPE ......
  VARS ......

      PRODECURE PRINTREC(I:  INTEGER); FORWARD; ** (a)
      PROCEDURE SAVEFILE; FORWARD;

      SEGMENT PROCEDURE INITVARS;
         .......
         .......

      END; { end seg-proc initvars }

      SEGMENT PROCEDURE ENTERDATA;
         .......
         PRINTREC(K); { call to printrec }
         .......
      END;  { end seg-proc initvars }

      SEGMENT PROCEDURE SEARCH;
         .......
         PRINTREC(K); { call to printrec }
         .......
      END;  { end seg-proc search }

      < remaining segment procedures or functions >

      PROCEDURE PRINTREC; { no  parameters here } ** (b)
         .......
         .......
      END; { end printrec }

      PROCEDURE SAVEFILE;
         .......
         .......
      END;  { end savefile }

BEGIN
  { main program begins here }
  ......
  ......
END.
```

Rule 2: Calls to segment procedures or functions within a loop of another procedure may cause excessive swapping of segments in and out of memory and should be avoided. For example, the program excerpt FOR I: = 1 TO N DO ENTERDATA; would be very inefficient.

If ENTERDATA were a segment procedure, the system would load the ENTERDATA segment into memory from disk N times. It is far more efficient (whether ENTERDATA is a segment procedure or not) to incorporate the loop within the procedure ENTERDATA, perhaps like this:

```
SEGMENT PROCEDURE ENTERDATA:
TYPE . . . . .
VAR  . . . . . ; CH: CHAR;
BEGIN
  REPEAT
     <body of ENTERDATA >
     WRITE('ENTER MORE DATA?');
     READLN(CH)
  UNTIL CH IN ['N','n']
END;
```

Not only are the disk accesses avoided, but the procedure is more general, and the segment ENTERDATA will remain in memory as long as needed. REPEAT or WHILE loops could be used for this purpose. (REPEAT loops are used for executing a group of statements one or more times; WHILE loops are used for zero or more repetitions.)

Rule 3: Only 16 segment procedures, segment functions, and regular units can be declared. Regular units will be treated in the next section. All code segments (a compiled or assembled program) contain a table called the segment dictionary for that code file. (Pages 266-270 of the operating system reference manual list all the information in the segment dictionary.) This table is referenced by the operating system during program execution and contains information about the different segments within a program, including name, location on disk, length, and type of code file. Only 16 slots have been provided in this table for segment information; thus, only 16 segments are allowed to be incorporated in a program. (By executing APPLE3:LIBMAP and entering the name of any code file, you can see what segments a code file contains. Try this on the SYSTEM.COMPILER for an eye-opener.) For more information on this, see pages 194-198 in the operating system reference manual.

When a code file is executed, the Pascal system maintains a run-time segment table in memory into which it loads the information from the executing program's segment dictionary. The run-time segment table has slots for 32 entries. Slots 0 and 2 through 6 are reserved for system use, slot 1 is reserved for your main program, and slot numbers from 7 on are assigned in ascending order to segment procedures and regular units used in the program. Sixteen slots are available for your program and 6 slots for the Pascal system. The remaining 10 may be filled by another type of unit, an intrinsic unit. Thus, your program may actually have up to 26 slots filled by a combination of segment procedures or functions, regular units, and intrinsic units. Table 1 illustrates the contents of the run-time segment table for the hypothetical database program.

Regular and Intrinsic Units

Besides conventional and segmented procedures and functions, you can define sections of code to be regular units or intrinsic units. Unlike segment procedures and functions, units are kept in memory throughout execution of the entire program. Thus, units are suitable only for frequently used routines.

Regular units are distinguished from intrinsic units (for example, TURTLEGRAPHICS or APPLESTUFF) by the fact that the code for regular units is physically inserted into your program and occupies a slot in the program's segment dictionary. The code for intrinsic units actually resides in the SYSTEM.LIBRARY on APPLE1 (the disk containing a major part of Apple Pascal and some of the system tables) and occupies a slot in the SYSTEM.LIBRARY's segment dic-

Slot(s)	Program
0	(operating system use)
1	DATABASE
2–6	(operating system use)
7	INITVARS
8	ENTERDATA
9	SEARCH
10–19	(empty)
20	TURTLEGRAPHICS
21	TURTLEGRAPHICS (data seg)
22	APPLESTUFF
23–28	(empty)
29	TRANSCEND
30	LONGINTIO
31	PASCALIO

Table 1: *Run-time segment table for a hypothetical database program.*

Listing 2: *The no-load option is specified in the body of the main program (*$N+*). Using the resident option (*$R APPLESTUFF*) keeps the unit containing the RANDOM function, which is called by RAND, in memory. In the procedure NTABLE, TRANSCEND, which contains the LOG function, is swapped in and out of memory on every function call.*

```
(*$S+*) { must use swapping option when compiling USES units statements }

PROGRAM UNITDEMO;
USES APPLESTUFF, TRANSCEND; { must be first statement }

  PROCEDURE RANDOMN;
  VAR  low,hi,I: INTEGER;
            A: ARRAY[1..10] OF INTEGER;

    FUNCTION RAND(L,H: INTEGER):INTEGER;
    VAR max,C,D: INTEGER;

    BEGIN
      RAND:=0;
      IF (L>H) OR (L<=0)  THEN EXIT(RAND); { error condition }
      IF L=H THEN RAND:=L
      ELSE  BEGIN
              C:=H-L+1;   max:=(MAXINT-H+L) DIV C+1;
              max:=max*(H-L) + (max-1);
              REPEAT D:=RANDOM UNTIL D<=max;
              RAND:=L+D MOD C
            END
    END;  { end rand...from p 102 language ref manual }

  BEGIN
    (*$R APPLESTUFF *)  { keeps unit APPLESTUFF in memory
                          during this procedure }
    WRITELN('ENTER RANGE OF RANDOM NUMBERS TO GENERATE:');
    WRITE('ENTER low: '); READLN(low);
    WRITE('ENTER hi: '); READLN(hi);
    FOR I:=1 TO 10 DO
      BEGIN   A[I]:=RAND(low,hi);  WRITE(A[I]:5)  END;
    WRITELN;  WRITELN
  END;

  PROCEDURE NTABLE;
  VAR  realnum,logbase2, nlogn, square: REAL;
                precision,colwidth,i: INTEGER;
  BEGIN
  { use resident option here to keep TRANSCEND in memory, otherwise this
  { unit will be reloaded 20 times in loop & disk runs continuously }

    precision:=1;
    colwidth:=10;
    WRITE('N':colwidth,'N**2':colwidth,'LOG2 N':colwidth);
    WRITE('N LOG2 N':colwidth); WRITELN;
    FOR i:=1 TO 20 DO
      BEGIN
        realnum:=i*10;            logbase2:=LOG(realnum)/LOG(2);
        square:=realnum*realnum;      nlogn:=realnum*logbase2;
        WRITE(realnum:colwidth:precision,square:colwidth:precision);
        WRITE(logbase2:colwidth:precision,nlogn:colwidth:precision);
        WRITELN
      END
  END;

BEGIN
  (*$N+*) { noload option: keeps units out of memory until used }
  RANDOMN;  NTABLE  { calls to two procedures }
END.
```

tionary. If the executing program uses any intrinsic units—as declared by a USES statement—then segment information from both the SYSTEM.LIBRARY's segment dictionary and your program's segment dictionary is read into the run-time segment table for use during execution. Intrinsic units are similar to libraries of built-in functions or procedures that may be shared by many programs but whose code is not inserted into the executing program's code file.

If you specify a regular unit, you must manually link it, using the Linker, to your program after it is compiled and before it is run. Using an intrinsic unit instead of a regular unit saves space in the program's code file on disk and saves you this task—the linking is done automatically if the units reside in the SYSTEM.LIBRARY. Why, then, you may be wondering, would anyone use regular units?

If the intrinsic units used in a program are your own creations, your program will not run on any other Apple Pascal system without installing these same units in that system's SYSTEM.LIBRARY. But if the units were created as regular units, the program is portable because the code for the unit resides in the program code file.

(Some intrinsic units occupy two slots in the segment dictionary of the SYSTEM.LIBRARY code file and subsequently in the run-time segment table. For example, intrinsic unit TURTLEGRAPHICS occupies two slots, one for its code segment and the other for its associated data segment.)

A unit can interact with code outside it only through identifiers (variables, procedures, and functions) declared in its interface part. Identifiers declared there are considered global identifiers and occupy space in memory until the entire program is finished. If a unit uses any variables of type FILE, they must be declared within the unit's interface section even if they are referenced only within the implementation part of the unit (a part not accessible to the main program except through interface identifiers).

Thus, a file buffer of approximately 600 bytes will remain allocated throughout execution of your program. If memory space needs to be conserved, change units using variables of type FILE into segment

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procedures so that the file buffer space will be deallocated when the segment procedure finishes executing.

The no-load Compiler option (*$N+*) placed at the beginning of the main program body after the BEGIN allows units to be treated exactly like segment procedures, which are loaded into memory only when called. Regard this option as a mixed blessing because units usually consist of frequently used routines or routines that are used in many different programs (i.e., compiled and installed in a library for use by other programs). Once the no-load option is used, it applies to all units used within one program, and it may cause excessive swapping of unit segments in and out of memory.

The program given in listing 2 illustrates problems created by using the no-load option without also using the resident option. The no-load option is inserted at the beginning of the main program so that units will be loaded only when needed, thus conserving memory space in return for increased execution time. APPLESTUFF, the first intrinsic unit declared, contains the random-number generator RANDOM, which the procedure RANDOMN uses to produce 10 random numbers in the range (low, high) that you set. TRANSCEND, the other intrinsic unit, contains the LOG function, which is used by procedure NTABLE to produce a table containing a number N, its square, its log base 2, and the number multiplied by its log base 2.

The resident option (*$R APPLESTUFF*) is placed at the beginning of RANDOMN (after the BEGIN) so that unit APPLESTUFF will remain in memory throughout execution of procedure RANDOMN. However, the resident option is not used in procedure NTABLE, causing the disk drive to run continuously while NTABLE is executing because it is continually reloading unit segment TRANSCEND. The resident option should be used at the beginning of NTABLE just as it is in the RANDOMN procedure when the no-load option is implemented. Thus, these options are frequently used together if the program incorporates more than one unit. Under ordinary circumstances, neither is necessary until all other ways to conserve memory are exhausted. (Details of these options are found in the *Apple Pascal Language Reference Manual* [Cupertino, CA: Apple Computer Inc., 1980], chapter 4 and the addendum.)

Listing 3: *The include-file option allows compilation of programs too large to fit into the Editor.*

```
(*$S+*)  { compiler swapping option }
PROGRAM DATABASE;

TYPE ......

VAR ......

  (*$I APPLE2:ENTER.TEXT *)
       { file that holds enterdata and other routines }

  (*$I APPLE2:SEARCH.TEXT *)
       { file that holds search an rest of procedures }

 BEGIN
   { main program goes here }
 END.
```

Compiler and Command-Level Options

There are a few additional methods of squeezing more from the available memory. By typing "S" from the highest command level, you can provide about 1100 more words (2200 bytes) of space for a code file at execution time. Actually, the "S" toggles the swapping option, which specifies whether part of SYSTEM.PASCAL will be swapped in and out of memory as needed. When the system is booted, this swapping option is automatically set to off.

The swapping option available from the command level also allows larger text files to be used in the Editor. Without this option, the maximum size file the Editor can handle without buffer overflow is about 36 blocks; with swapping on, about 40 blocks. (A block contains 512 bytes.)

The Compiler option (*$S+*), where S stands for swapping, has already been mentioned in connection with compiling programs that use units. This option slows the compilation process but allows the extra memory needed for symbol-table generation when very large programs are compiled. Have you ever compiled a program that appeared to blow up in the middle of the compiling process (i.e., the screen became filled with inverse, normal, and flashing characters or produced a stack-overflow message during compilation)? The "S" swapping option can correct this problem (see the first line in listings 2 and 3). Even more swapping will be done by specifying (*$S++*) at the beginning of a program text file; you'll notice an appropriate decrease in speed of compilation.

The include-file option, (*$I *filename**), enables compilation of programs too large to fit in the Editor. The size of text file that the Editor can handle is limited. You can, however, have several text files in one program by using the include-file option(s) to instruct the Compiler to insert the text file named in the option into the compilation process at that point, as illustrated in listing 3.

Summary

Although it is quite useful, knowledge of how to use regular or intrinsic units is not required in order to enjoy the benefits of segmentation. These techniques, along with the Compiler and command-level options allow not only maximum use of internal memory but also maximum use of the limited amount of secondary storage on disk. Even with an increase in main memory, as in the Apple III, memory conservation soon becomes necessary as programmers think of bigger and better programs.■

About the Author

Jill David (221 Woodcrest, Richardson, TX 75080) has a master's degree in computer science from the University of Texas at Dallas. She currently teaches Pascal programming there.

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by David Alan Hayes

Imagine that your computer turns on the lights and flashes a welcoming message on its display screen the instant you walk into a room. It's not a far-off possibility. With the right equipment, your Atari 400 or 800 can sense your (or anyone's) presence and control AC-powered devices such as lamps, household appliances, and even burglar alarms.

Some Software Techniques

A great deal of information can be determined about the world by simply monitoring switches. An open switch on a window could indicate that a thief is entering your home. A closed switch might indicate that someone is standing on a concealed switch mat (like those at supermarket exits). Wouldn't it be nice if a lamp came on automatically if a light-sensitive switch indicated that room lighting was too dim? An electronic sound switch could monitor a sleeping baby. If you do the work yourself, you can install an elaborate system of switches throughout your home for a few hundred dollars. You can then turn your Atari computer into a powerful energy-management and burglar-alarm system. All of this can be done through the peripheral interface adapter (PIA) in your Atari computer.

The PIA (figure 1) is a large-scale integrated circuit whose primary function in the Atari is to link the joystick to the computer. It monitors the four normally open switches that indicate the direction the joystick has been tilted (see figure 2 and listing 1).

The PIA monitors the joysticks input via two 8-bit ports labeled PORTA and PORTB. Because these ports are bidirectional, they can also be used to set switches. PORTA and PORTB can be reset as outputs easily via the PIA's two 8-bit data-direction registers (DDRA and DDRB). Placing a 0 in a bit position in DDRA or DDRB causes the corresponding controller jack pin to act as an input; a 1 causes it to act as an output (figure 2).

DDRA has the same address as PORTA (hexadecimal D300, decimal 54016). Similarly, DDRB has the same address as PORTB (hexadecimal D301, decimal 54017). Therefore, a control program has to tell the PIA which register it wishes to address before addressing 54016 or 54017. The program can do this by using two

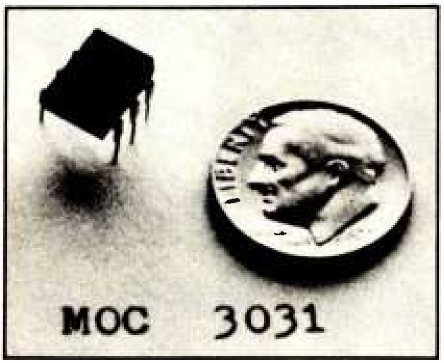


Photo 1: *The MOC3031 is the heart and brains of the solid-state relay described in the text. Don't let its small size fool you; it can protect a computer from voltage spikes up to 7500 V. It costs about $2 from any Motorola distributor.*

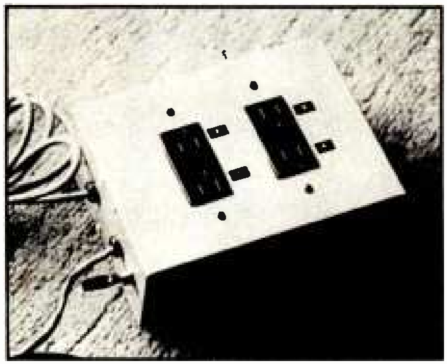
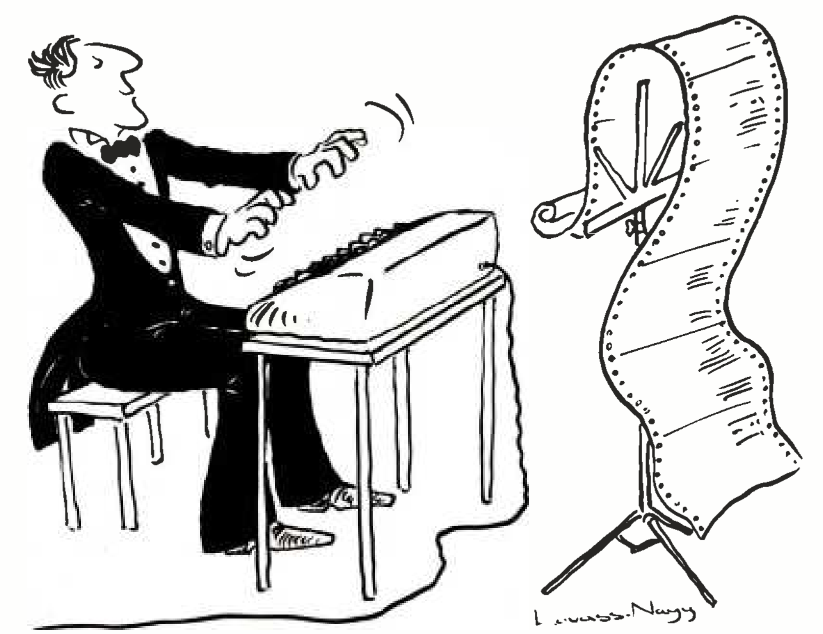


Photo 2: *The chassis of the four-channel SSR prototype the author built contains a control cable, which plugs into any Atari 400/800 controller jack and a power cord.*



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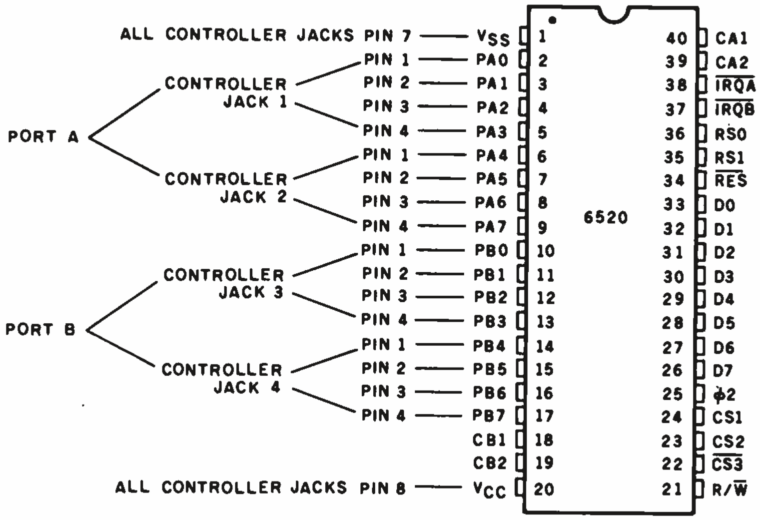

Figure 1: *The peripheral interface adapter. Pins 2 through 17 connect indirectly through a 220-ohm resistor to the controller jack pins shown. These pins can be used as input or output.*

Figure 2a: *Subminiature D-type jack on Atari chassis for joystick.*

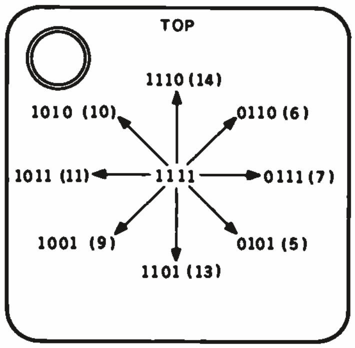

Figure 2b: *Joystick positions and their corresponding digital codes (decimal value in parentheses).*

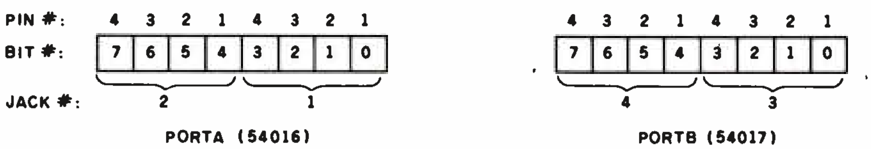

Figure 2c: *I/O ports used to access joysticks.*

other 8-bit registers called Port A Control (PACTL, 54018) and Port B Control (PBCTL, 54019). Setting bit 2 of these registers to 1 causes the computer to address PORTA or PORTB. All other bits of PACTL and PBCTL should be left as the operating system set them up. Listing 2 demonstrates how to set up pins 1 through 4 of controller jack 1 (farthest left) as an output. These pins can control up to four solid-state relays. It also sets up pins 1 through 4 of controller jacks 2, 3, and 4 as inputs to monitor up to 12 switches.

The Hardware Problem

How can a computer, which operates on little power, control the raw energy from electrical outlets without endangering people and machines? An integrated circuit (IC) called an optoisolator offers a surprisingly simple and inexpensive solution. The IC is so named because its input is electrically isolated from its output. This circuit uses low-level computer signals to drive an LED (light-emitting diode) that in turn controls a solid-state relay (triac).

Motorola has developed an optoisolator, called the MOC3031, that will protect a computer from power-line transients as high as 7500 volts (V). In addition, the MOC3031 has a zero-crossing switch that switches power on or off only when the power-line voltage is at ground potential (figure 3). This prevents the electromagnetic interference (EMI) that usually occurs whenever electrical power is turned on or off rapidly. EMI can cause snow-storm effects on a video screen and popping sounds from speakers. It may even cause your computer to malfunction.

Figure 4 shows a typical solid-state relay circuit employing an MOC3031. You should consider three important specifications when selecting a triac for the circuit (see table 1). The repetitive peak off-state voltage (V_{DROM}) specifies the amount of voltage that the triac will block when switched off. For home power control, V_{DROM} must be greater than 200 V.

The triac's on-state RMS (root mean square) current (I_O) specifies the

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Circle 230 on inquiry card.

Listing 1: *This program reads the joystick controller jacks directly through the PIA.*

```
0 REM LISTING 1
10 DIM DIRECTION$(2):REM DIMENSION STRING
20 REM PIA READ DEMONSTRATION
25 REM USING JOYSTICK.
30 REM YOU CAN SAVE SOME TYPING IF YOU
40 REM LEAVE OUT THE REM COMMENTS.
50 ? "}":REM CLEAR SCREEN
60 PACTL=54018:REM PORT A (JS PORTS 1 & 2, PINS 1-4) CONTROL REGISTER.
70 PBCTL=54019:REM PORT B (JS PORTS 3 & 4, PINS 1-4) CONTROL REGISTER.
80 PORTA=54016:REM PORT A I/O REGISTER
90 PORTB=54017:REM PORT B I/O REGISTER
100 DDRA=PORTA:REM 0=INPUT, 1=OUTPUT  FOR EACH OF EIGHT BITS IN PORT A.
110 DDRB=PORTB:REM 0=INPUT, 1=OUTPUT  FOR EACH OF EIGHT BITS IN PORT B.
115 ? "OS INITIALIZED VALUES":?
120 ? "PACTL= ";PEEK(PACTL):REM PRINT START VALUE FOR PACTL
130 ? "PBCTL= ";PEEK(PBCTL):REM PRINT START VALUE FOR PBCTL
140 POKE PACTL,56:REM ALLOWS DDRA TO  BE ADDRESSED SINCE BIT 2 = 0
150 ? "DDRA= ";PEEK(DDRA):REM PRINT    START VALUE FOR DDRA
160 POKE PACTL,60:REM SET PACTL BACK  TO START VALUE
170 POKE PBCTL,56:REM ALLOWS DDRB TO  BE ADDRESSED SINCE BIT 2 = 0
180 ? "DDRB= ";PEEK(DDRB):REM PRINT    START VALUE FOR DDRB
190 POKE PBCTL,60:REM SET PBCTL BACK  TO START VALUE
200 ? "NOTICE THAT BOTH DDRA/B ARE ZERO":? "(THIS MEANS THAT ALL PINS ARE SETUP
AS INPUT BY THE OS.)"
210 ? :? " USE ONLY ONE JOYSTICK"
215 OLDSTICKA=-1:OLDSTICKB=-1:REM SET UP DUMMY VARIABLES
220 FINDSTICKA=230:REM INITIALIZE LINENUMBER VARIABLE
230 STICKA=PEEK(PORTA):REM GET VALUE  AT PORT A FROM PIA
240 IF STICKA=OLDSTICKA THEN GOTO FINDSTICKA:REM GET STICKA VALUE UNTIL STICKA V
ALUE CHANGES
250 FINDPORT=1000:REM FIND PORT SUBROUTINE NUMBER
260 IF STICKA<255 THEN GOSUB FINDPORT:REM FIND THE INPUT PORT # IF STICKA INPUT
FOUND
270 FINDDIRECTION=2000:REM FIND DIRECTION OF JS TILT SUBROUTINE LINE NUMBER
280 IF STICKA<255 THEN GOSUB FINDDIRECTION:REM FIND DIRECTION OF JS TILT IF STIC
KA INPUT FOUND
290 FINDSTICKB=340:REM INITIALIZE FINDSTICKB LINE NUMBER VARIABLE
295 OLDSTICKA=STICKA:REM SET UP OLD STICKA VALUE
300 IF STICKA=255 THEN OLDSTICKA=-1:GOTO FINDSTICKB:REM CHECK PORT B INPUT
310 ? :? "PORTA = ";STICKA,"JS PORT # ";PORT,"DIRECTION IS ";DIRECTION$:REM PRIN
T INFORMATION FROM PIA
320 OLDSTICKA=STICKA:REM OLD STICK WILL BE USED TO SEE IF STICKA INPUT HAS CHANG
ED
330 GOTO FINDSTICKA
340 STICKB=PEEK(PORTB):REM GET VALUE  AT PORT B FROM PIA
350 IF STICKB=OLDSTICKB THEN GOTO FINDSTICKB:REM GET STICKB VALUE UNTIL STICKB V
ALUE CHANGES
360 FINDPORT=1000:REM FIND PORT # SUBROUTINE NUMBER
370 IF STICKB<255 THEN GOSUB FINDPORT:REM FIND INPUT PORT # IF STICKB INPUT FOUN
D
380 FINDDIRECTION=2000:REM FIND DIRECTION OF JS TILT SUBROUTINE NUMBER
390 IF STICKB<255 THEN GOSUB FINDDIRECTION:REM FIND DIRECTION OF JS TILT IF STIC
KB INPUT FOUND
400 OLDSTICKB=STICKB:REM OLD STICK WILL BE USED TO SEE IF STICKB INPUT HAS CHANG
ED
410 IF STICKB=255 THEN OLDSTICKB=-1:GOTO FINDSTICKA:REM CHECK INPUT AT STICKA
430 ? :? "PORTB = ";STICKB,"JS PORT # ";PORT,"DIRECTION IS ";DIRECTION$:REM PRIN
T INFORMATION FOUND
440 GOTO FINDSTICKB
1000 REM FIND PORT #
1010 IF STICKA<255 AND STICKA>240 THEN PORT=1:REM IF ANY OF LOW NIBBLE BITS IN S
TICKA ARE 0 THEN PORT 1 HAS INPUT
1020 IF STICKA<240 THEN PORT=2:REM IF ANY OF HIGH NIBBLE BITS OF STICKA ARE 0 TH
EN PORT 2 HAS INPUT
1030 IF STICKB<255 AND STICKA>240 THEN PORT=3:REM IF ANY OF LOW NIBBLE BITS IN S
TICKA ARE 0 THEN PORT 3 HAS INPUT
1040 IF STICKB<240 THEN PORT=4:REM IF ANY OF HIGH NIBBLE BITS OF STICKB ARE 0 TH
EN PORT 4 HAS INPUT
1050 RETURN
2000 REM FIND DIRECTION OF JS TILT (ALL NUMBERS ARE IN DECIMAL)
2010 IF PORT=1 OR PORT=3 THEN 2500:REM GOTO LOW NIBBLE CHECK
2020 REM HIGH NIBBLE CHECK
2030 IF STICKA=239 OR STICKB=239 THEN DIRECTION$="N":REM 239 IS NORTH TILT
2040 IF STICKA=223 OR STICKB=223 THEN DIRECTION$="S":REM 223 IS SOUTH TILT
2050 IF STICKA=191 OR STICKB=191 THEN DIRECTION$="W":REM 191 IS WEST TILT
2060 IF STICKA=127 OR STICKB=127 THEN DIRECTION$="E":REM 127 IS EAST TILT
2070 IF STICKA=175 OR STICKB=175 THEN DIRECTION$="NW":REM 175 IS NW TILT
2080 IF STICKA=159 OR STICKB=159 THEN DIRECTION$="SW":REM 159 IS SW TILT
2090 IF STICKA=111 OR STICKB=111 THEN DIRECTION$="NE":REM 111 IS NE TILT
2100 IF STICKA=95 OR STICKB=95 THEN DIRECTION$="SE":REM 95 IS SE TILT
2110 RETURN
2500 REM LOW NIBBLE CHECK
2510 IF STICKA=254 OR STICKB=254 THEN DIRECTION$="N":REM 254 IS NORTH TILT
2520 IF STICKA=253 OR STICKB=253 THEN DIRECTION$="S":REM 253 IS SOUTH TILT
2530 IF STICKA=251 OR STICKB=251 THEN DIRECTION$="W":REM 251 IS WEST TILT
2540 IF STICKA=247 OR STICKB=247 THEN DIRECTION$="E":REM 247 IS EAST TILT
2550 IF STICKA=250 OR STICKB=250 THEN DIRECTION$="NW":REM 250 IS NW TILT
2560 IF STICKA=249 OR STICKB=249 THEN DIRECTION$="SW":REM 249 IS SW TILT
2570 IF STICKA=246 OR STICKB=246 THEN DIRECTION$="NE":REM 246 IS NE TILT
2580 IF STICKA=245 OR STICKB=245 THEN DIRECTION$="SE":REM 245 IS SE TILT
2590 RETURN
```

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Listing 2: *This program sets up controller jack 1 (farthest left) as an output jack and the others as input jacks.*

```
0 REM LISTING 2
1 DIM A$(3)
10 FOR ADDRESS=1536 TO 1571:READ INSTRUCTION:POKE ADDRESS,INSTRUCTION:NEXT ADDRE
SS:REM LOAD ASM PROGRAM
20 DATA 104.104.133,205,104,133,204,104.5,205,133,213,104,5,204,133,212,96
25 REM LOGICAL OR ROUTINE (1536)
30 DATA 104,104,133,205,104,133,204,104,37,205,133,213,104,37,204,133,212,96
31 REM LOGICAL AND ROUTINE (1554)
40 PACTL=54018:PORTA=54016:PORTB=54017:REM ASSIGN ADDRESS NUMBERS
50 POKE PACTL,56:POKE PORTA,15:REM SET UP CONROLLER JACK #1 (CJ1) AS OUTPUT, DDR
A = 00001111
55 REM DDRB IS SET UP AS 0, 00000000 (ALL INPUT) BY THE OPERATING SYSTEM
60 POKE PACTL,60:REM ALLOW PORTA TO BE ADDRESSED
70 POKE PORTA,0:REM SET OUTPUT (CJ1, PIN 1-4) TO ZERO
80 REM INITIALIZATION COMPLETE
90 ? "}"
100 POSITION 8,5
110 ? "CONTROLLER JACK MENU":? :?
120 ? "              1)  JACK 1":?
130 ? "              2)  JACK 2":?
140 ? "              3)  JACK 3":?
150 ? "              4)  JACK 4":?
160 TRAP 400:? :? :? "                  WHICH JACK";:INPUT JACKNUM
170 IF JACKNUM<1 OR JACKNUM>4 THEN 400
180 IF JACKNUM=1 THEN ? "}":? "CONTROLLER JACK #1 IS THE OUTPUT JACK.":GOTO 190
185 GOTO 290
190 GOSUB 1000
210 ? :? "                 OUTPUT MENU"
220 ? :? "  1)  PIN 1 HIGH      5)  PIN 1 LOW"
230 ? :? "  2)  PIN 2 HIGH      6)  PIN 2 LOW"
240 ? :? "  3)  PIN 3 HIGH      7)  PIN 3 LOW"
250 ? :? "  4)  PIN 4 HIGH      8)  PIN 4 LOW"
260 ? :? :? :? "            SELECT OPTION";:TRAP 400:INPUT ANS
270 IF ANS<1 OR ANS>8 THEN 400
280 ON ANS GOSUB 500,550,600,650,700,750,800,850
283 POSITION 0,3
285 GOSUB 1000
288 FOR WT=0 TO 1500:NEXT WT:GOTO 90
290 ? "}"
300 POSITION 2,7:? "CONTROLLER JACK #";JACKNUM;" IS AN INPUT JACK."
310 IF JACKNUM=2 THEN JACKVAL=USR(1554,PEEK(PORTA),240):GOTO 320:REM 11110000 AN
D XXXXXXXX = JACKVAL = XXXX0000
315 GOTO 340
320 ? :? "THE VALUE AT JACK #";JACKNUM;" IS ";JACKVAL
330 GOTO 385
340 IF JACKNUM=3 THEN JACKVAL=USR(1554,PEEK(PORTB),15):GOTO 320:REM JACKVAL = 00
00XXXX
370 JACKVAL=USR(1554,PEEK(PORTB),240):GOTO 320:REM JACKVAL = XXXX0000
385 ? :? :? :? "    TO CONTINUE PRESS  RETURN ":TRAP 90:INPUT DUMMY
390 GOTO 90
400 ? "}"
410 POSITION 12,12
420 ? "WHAT'S  WRONG"
430 FOR WT=0 TO 500:NEXT WT
440 GOTO 90
500 REM TURN PIN ONE ON (HIGH)
510 VAL=USR(1536,PEEK(PORTA),1)
520 POKE PORTA,VAL
530 RETURN
550 REM TURN PIN TWO ON (HIGH)
560 VAL=USR(1536,PEEK(PORTA),2)
570 POKE PORTA,VAL
580 RETURN
600 REM TURN PIN THREE ON (HIGH)
610 VAL=USR(1536,PEEK(PORTA),4)
620 POKE PORTA,VAL
630 RETURN
650 REM TURN PIN FOUR ON (HIGH)
660 VAL=USR(1536,PEEK(PORTA),8)
670 POKE PORTA,VAL
680 RETURN
700 REM TURN PIN ONE OFF (LOW)
710 VAL=USR(1554,PEEK(PORTA),254)
720 POKE PORTA,VAL
730 RETURN
750 REM TURN PIN TWO OFF (LOW)
760 VAL=USR(1554,PEEK(PORTA),253)
770 POKE PORTA,VAL
780 RETURN
800 REM TURN PIN THREE OFF (LOW)
810 VAL=USR(1554,PEEK(PORTA),251)
820 POKE PORTA,VAL
830 RETURN
850 REM TURN PIN FOUR OFF (LOW)
860 VAL=USR(1554,PEEK(PORTA),247)
870 POKE PORTA.VAL
880 RETURN
1000 JACK1VAL=USR(1554,PEEK(PORTA),15):REM 00001111 AND XXXXXXXX = JACK1VAL = 00
00XXXX
1010 ? :? "THE PRESENT VALUE AT CONTROLLER JACK #1 IS ";JACK1VAL
1020 RETURN
```

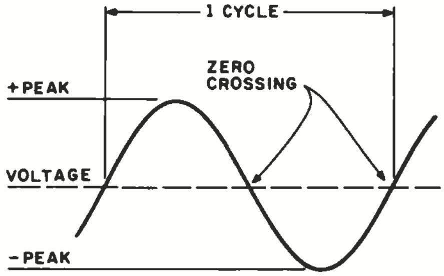

Figure 3: *Switching power on and off at the zero-crossing points of the AC cycle. The circuit shown in figure 4 uses this technique to prevent production of electromagnetic interference.*

amount of current that can flow through the triac. Usually I_O is determined by the manufacturer at near ideal conditions. Therefore, I_O should not be exceeded unless you use a Sherman tank as a heat sink. I_O must be greater than the expected load current. Keep in mind that your home's circuit breakers will blow when load currents exceed about 20 amps (A).

The triac's gate turn-on current (I_{GTO}) specifies the amount of gate current required to turn on the triac. The I_{GTO} must be less than 0.1 A to work with the MOC3031.

All power triacs should be mounted on heat sinks for best results. The metal case of a power triac is usually one of its main power terminals also. Therefore, the triac and its heat sink must be electrically insulated from all other hardware to prevent short circuits.

Resistor R1 in figure 4 allows about 18 milliamps (mA) to flow into pin 1 of the MOC3031. This current energizes an infrared diode, which in turn activates the triac driver inside the MOC 3031. The TTL (transistor-transistor logic) levels in an Atari's controller jacks will not provide the 18 mA needed, so the 7400 NAND gate (IC1) acts as a current buffer. Switch S1 allows you to disconnect the computer from the relay circuit as a safety measure (see photo 2).

The value of resistor R2 will vary depending on the I_{GTO} of T1 and the desired turn-on voltage. Table 1 lists the value in ohms (Ω) of R2 for several solid-state relays.

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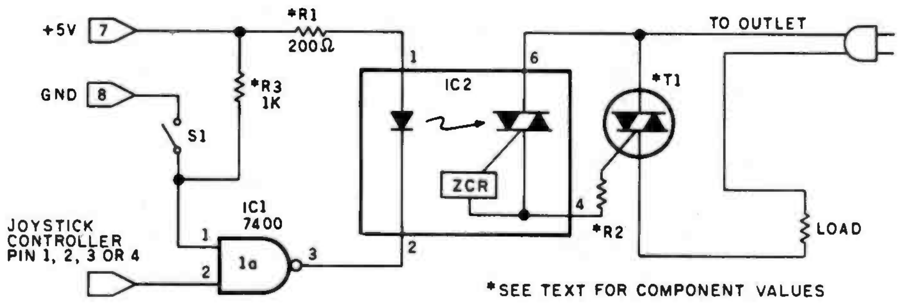

Figure 4: *This solid-state relay isolates a computer from up to 7500 V, produces no EMI when switching, runs quietly because it has no moving parts, and connects directly to an Atari 400/800.*

Triac	V_{DROM}	I_O	Typical I_{GTO}	Maximum Power Delivered $P = VI_O$	R2
Motorola SC 245B	200 V	10 A	25 mA	1200 W	600 Ω
Radio Shack 276-1001	200 V	6 A	50 mA	700 W	300 Ω
276-1000	400 V	6 A	50 mA	700 W	300 Ω
RCA T2700B	200 V	6 A	15 mA	700 W	1000 Ω
Texas Instruments TIC-246B	200 V	15 A	50 mA	1800 W	300 Ω

Table 1: *Some common triacs and their specifications.*

Power and Corruption

This circuit has two limits to the amount of power it can control—the I_O of the triac (see table 1 for maximum triac currents, and hence the maximum power that can be delivered) and the amount of power an outlet can deliver. The current rating of most outlets is 15 A. Therefore, the maximum safe power delivered from your receptacle (calculated as V × A or 120 × 15) is 1800 watts.

Building the Future

Here are some suggestions for those of you who build this circuit. Make sure you build it exactly as shown in figure 4. If necessary, find someone who can help you. *Do not* connect pins 3 and 5 of the MOC3031 to anything. Remember you are dealing with lethal voltages, so be careful.

Your Atari computer can do a lot more than play games. You can control and monitor the environment to the limits of your imagination. I recommend that you experiment with the hardware and software presented here and build your own custom system. ■

The MOC3031 optoisolator can be purchased from any Motorola distributor, such as Hall-Mark Electronics or Hamilton/Avnet. Their price for small quantities is about $2 each. If you wish to order by phone, call (800) 555-1212 and ask for the 800 number of the nearest Hall-Mark or Hamilton/Avnet distributor.

* * *

The author will supply a cassette or disk with the programs listed in this article plus a universal output controller program if you send your name and address with $8 for cassette or $9 for disk to David Alan Hayes, 3205 Lewisburg Dr., Huntsville, AL 35810. An instruction sheet will be included.

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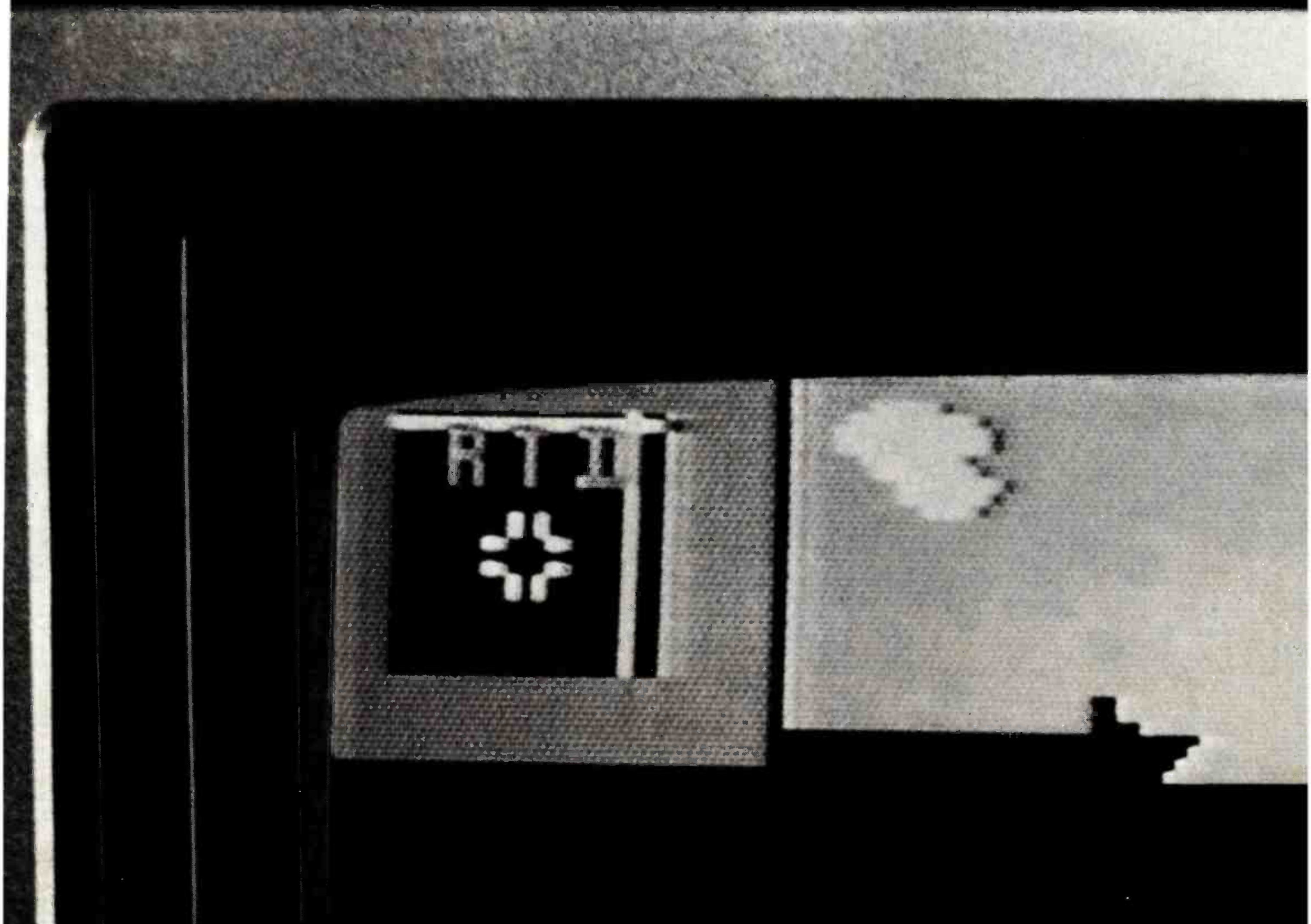

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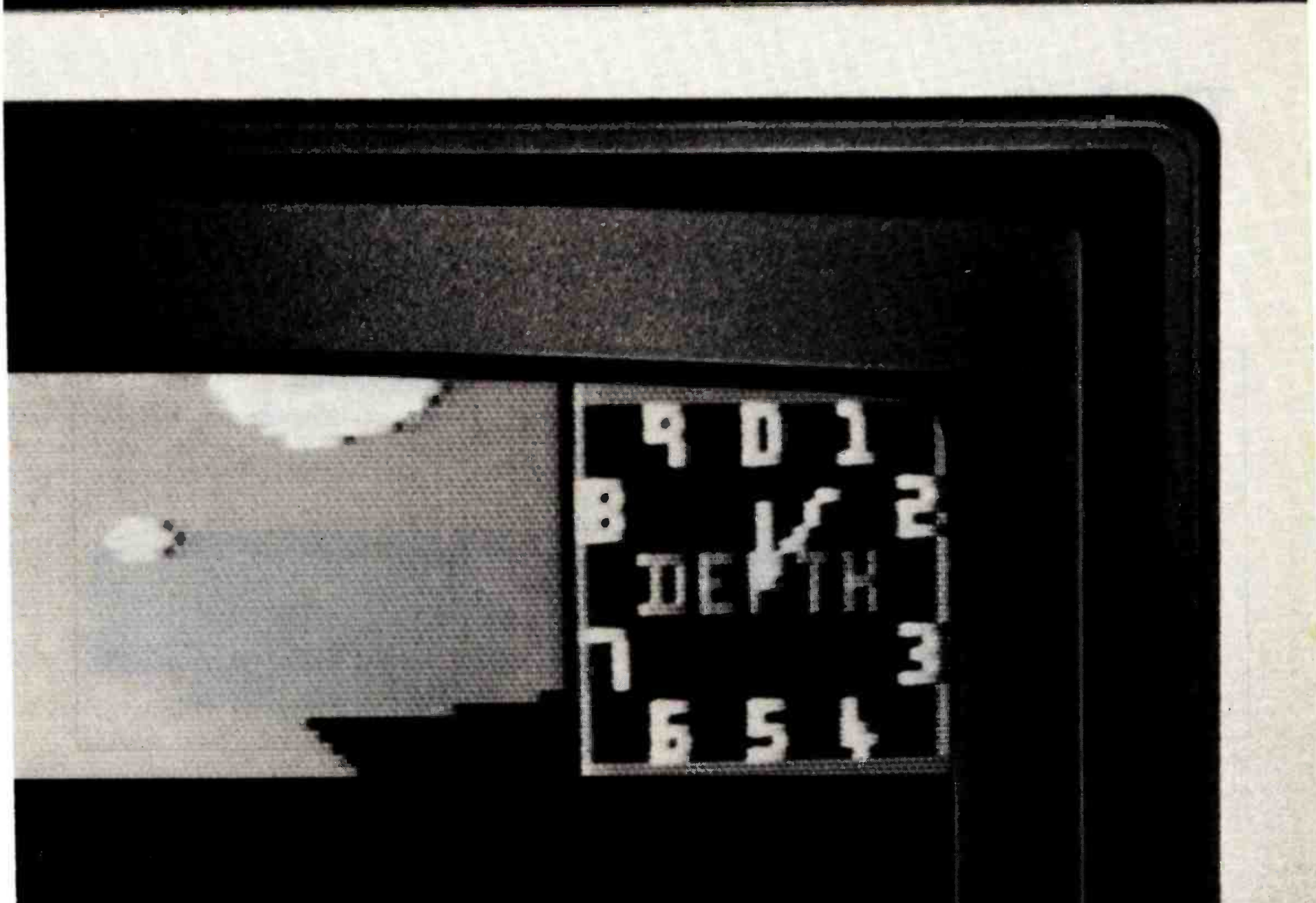

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Redefining the Apple Keyboard

With minor software modifications, you can rearrange the keyboard on the Apple II into a Dvorak layout.

by Bob Wiseman

Photo 1: *The standard Apple II keyboard with the QWERTY key arrangement. Note that many frequently used keys (E, T, R, etc.) are not on the row where the fingers normally rest.*

Photo 2: *After gently prying the key caps off and rearranging them, you have the Dvorak simplified keyboard. The arrangement of the numerals shown here is the classic Dvorak arrangement. The recently approved American National Standards Institute Dvorak-layout keyboard standard (X4.22-1983) specifies that the numerals be in ascending order, as in the common QWERTY arrangement.*

The familiar QWERTY-style key layout, a boon to touch-typists trained on it but a bane to almost everyone else, stares up from the keyboard of most microcomputers (photo 1). Alternative arrangements have drifted in and out of the picture but none has really caught on. Recently, however, the Dvorak simplified keyboard (DSK) has been gaining the attention of human-factors engineers. Proponents of the Dvorak layout believe that it's easier to learn and that a typist trained on that keyboard can achieve higher speeds. On the Dvorak layout, the most-used letters are on the middle row, the home keys, where the fingers usually rest (photo 2).

Apple II owners dissatisfied with the QWERTY layout or eager to experiment can redefine the meaning of any key without resorting to soldering. They can even assign a sequence of characters (macro) to a key. The programs that accomplish this rearrangement are as follows:

- KEYDEF: Written in Applesoft BASIC, this routine (see listings 1 and 2) creates a keyboard table with two parts. The first part is a keyboard-translation table; the second

Text continued on page 446

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Listing 1: *KEYDEF is an Applesoft BASIC program that simplifies the creation of the keyboard lookup and macroinstruction tables. It will prompt you through the reassignment of the keys and the creation of keyboard-character macroinstructions.*

```
]LIST

5  HIMEM: 38144
10  GOSUB 9000: REM  INSTRUCTIONS

20  GOSUB 8000: REM  INITIALIZE
30  GOSUB 2000: REM  ASSIGN KEYS
40  GOSUB 3000: REM  ASSIGN MACRO
   S
50  GOSUB 4000: REM  SAVE KEYBOAR
   D TABLE
60  END
2000  HOME
2010  PRINT "HERE YOU MAY REDEFIN
   E THE KEYS TO"
2020  PRINT "REPRESENT NEW CHARAC
   TERS.  FOR INSTANCE"
2030  PRINT "YOU MAY DEFINE THE -
   A- KEY SO THAT IT"
2040  PRINT "WILL INPUT THE -B- C
   HARACTER."
2050  PRINT
2060  PRINT "TO MAKE THESE CHANGE
   S, DO THE FOLLOWING"
2070  PRINT " 1) FIRST PUSH THE K
   EY THAT YOU WANT"
2080  PRINT "    TO RE-ASSIGN."
2090  PRINT " 2) THEN ENTER THE C
   HARACTER THAT YOU"
2100  PRINT "    WANT TO ASSIGN T
   O THE KEY IN 1)."
2110  PRINT
2120  PRINT "PUSH THE SPACE BAR T
   O QUIT."
2130  PRINT
2140  PRINT "READY:": PRINT
2150  PRINT "KEY ";
2160  GET A$
2165  IF A$ = " " THEN  PRINT : PRINT
   : RETURN
2166 A$ = A$ +  CHR$ (0)
2170  PRINT A$;" (#"; ASC (A$);")
   ";
2180  PRINT "-> CHARACTER ";
2190  GET B$
2196 B$ = B$ +  CHR$ (0)
2200  PRINT B$;" (#"; ASC (B$);")
   ."
2210  POKE LOOK +  ASC (A$), ASC
   (B$) + 128
2220  GOTO 2150
3000  HOME
3010  PRINT "HERE YOU MAY DEFINE
   A KEY SO THAT WHEN"
3020  PRINT "IT IS PRESSED, AN EN
   TIRE WORD OR "
3030  PRINT "PHRASE WILL BE PRODU
   CED.  THESE ARE"
3040  PRINT "CALLED MACROS."
3050  PRINT
3060  PRINT " 1) FIRST PUSH THE K
   EY"
3080  PRINT " 2) THEN ENTER THE M
   ACRO. END THE MACRO"
3090  PRINT "    WITH A RETURN."
3100  PRINT
3102  PRINT "QUIT BY ENTERING A S
   PACE FOR THE KEY."
3104  PRINT
3110  PRINT 128 - FSET;" MACRO PO
   SITIONS AVAILABLE"
3120  PRINT "KEY ";
3130  GET A$
3140  IF A$ = " " THEN  PRINT : PRINT
   : RETURN
3150 A$ = A$ +  CHR$ (0)
3155  PRINT A$;" (#"; ASC (A$);")
   ";
3160  POKE LOOK +  ASC (A$),FSET
3170  PRINT "-> MACRO ";
3200  GET B$
3205  PRINT B$;
3210  IF B$ =  CHR$ (13) THEN  GOTO
   3400
3220  IF B$ = "" THEN B$ =  CHR$
   (0)
3240  POKE MACR + FSET, ASC (B$) +
   128
3250 C$ = B$
3260 FSET = FSET + 1
3280  GOTO 3200
3400  POKE MACR + FSET - 1, ASC (
   C$)
3410  IF FSET < 128 THEN  GOTO 31
   10
3420  PRINT "MACRO TABLE FULL --
   SORRY."
3430  RETURN
4000  HOME
4010  PRINT "BEFORE WE SAVE THE T
   ABLE THAT HAS BEEN"
4020  PRINT "CREATED, HERE IS ONE
    FINAL OPPORTUNITY"
4030  PRINT "TO MAKE A CHANGE.  A
   NSWER WITH Y OR N."
4040  PRINT
4050  PRINT "WOULD YOU LIKE TO AS
   SIGN MORE KEYS?"
4060  GET A$: PRINT A$
4070  IF A$ = "Y" THEN  GOSUB 200
   0: GOTO 4000
4075  IF A$ <  > "N" THEN  GOTO 4
   050
4080  PRINT
4090  PRINT "WOULD YOU LIKE TO AS
   SIGN MORE MACROS?"
4100  GET A$: PRINT A$
4110  IF A$ = "Y" THEN  GOSUB 300
   0: GOTO 4000
4115  IF A$ <  > "N" THEN  GOTO 4
   090
4120  PRINT
4130  PRINT "WOULD YOU LIKE TO SA
   VE THE KEYBOARD"
4140  PRINT "TABLE THAT YOU HAVE
   CREATED?"
4150  GET A$
4160  IF A$ = "N" THEN  PRINT "FI
   LE NOT SAVED": RETURN

4170  IF A$ <  > "Y" THEN  GOTO 4
   130
4180  PRINT
4190  PRINT "PLEASE ENTER A NAME
   FOR THE FILE:"
4200  INPUT "FILE NAME? ";A$
4300  IF A$ = "" OR A$ = " " THEN
    GOTO 4130
4310  REM   HERE IS DOS BINARY FI
   LE SAVE
4320  PRINT
4330  PRINT D$;"BSAVE ";A$;",A$95
   00,L$100"
4340  PRINT D$
4350  PRINT "FILE ";A$;" IS NOW S
   AVED."
4900  RETURN
8000  HOME
8010 LOOK = 38144
8020 MACR = LOOK + 95
8030 FSET = 1
8040  REM  INITIALIZE TABLE WITH
   REGULAR KEYBOARD
8050  FOR X = 0 TO 93
8060  POKE LOOK + X,X + 128
8070  NEXT X
8080  POKE LOOK + 94,0
8090  POKE LOOK + 95,0
8100 D$ =  CHR$ (4)
8900  RETURN
9000  HOME
9010  PRINT "********************
   ********************"
9020  PRINT "*
                                      *"
9030  PRINT "*  KEYDEF PROGRAM --
    BY BOB WISEMAN    *"
9035  PRINT "*              (C) 198
   2 WISEMAN           *"
9040  PRINT "*
                                      *"
9050  PRINT "* THIS PROGRAM WILL
   ALLOW YOU TO :      *"
9060  PRINT "* 1) REASSIGN THE KE
   YS ON THE           *"
9070  PRINT "*     KEYBOARD TO NEW
    CHARACTERS         *"
9080  PRINT "* 2) ASSIGN TO A KEY
    A WORD OR PHRASE.*"
9090  PRINT "*
                                      *"
9100  PRINT "********************
   ********************"
9120  PRINT
9130  PRINT " --> PUSH ANY KEY TO
   CONTINUE"
9140  GET A$
9150  RETURN
```

Listing 2: *KEYDEF sample run. The example shows the changes necessary to convert the middle row of keys from QWERTY to DSK (Dvorak simplified keyboard) format. In addition, two macroinstructions are entered. The first causes CTRL-C to produce CATALOG; the second changes CTRL-P to PRINT. The new keyboard table is stored on disk with the filename DSK.*

```
]PR#0
]RUN KEYDEF
****************************************
*                                      *
*  KEYDEF PROGRAM -- BY BOB WISEMAN    *
*            (C) 1982 WISEMAN          *
*                                      *
* THIS PROGRAM WILL ALLOW YOU TO :     *
* 1) REASSIGN THE KEYS ON THE          *
*     KEYBOARD TO NEW CHARACTERS       *
* 2) ASSIGN TO A KEY A WORD OR PHRASE.*
*                                      *
****************************************

--> PUSH ANY KEY TO CONTINUE
HERE YOU MAY REDEFINE THE KEYS TO
REPRESENT NEW CHARACTERS.  FOR INSTANCE
YOU MAY DEFINE THE -A- KEY SO THAT IT
WILL INPUT THE -B- CHARACTER.

TO MAKE THESE CHANGES, DO THE FOLLOWING
 1) FIRST PUSH THE KEY THAT YOU WANT
    TO RE-ASSIGN.
 2) THEN ENTER THE CHARACTER THAT YOU
    WANT TO ASSIGN TO THE KEY IN 1).

PUSH THE SPACE BAR TO QUIT.

READY:

KEY S (#83) -> CHARACTER O (#79).
KEY D (#68) -> CHARACTER E (#69).
KEY F (#70) -> CHARACTER U (#85).
KEY G (#71) -> CHARACTER I (#73).
KEY H (#72) -> CHARACTER D (#68).
KEY J (#74) -> CHARACTER H (#72).
KEY K (#75) -> CHARACTER T (#84).
KEY L (#76) -> CHARACTER N (#78).
KEY ; (#59) -> CHARACTER S (#83).
KEY

HERE YOU MAY DEFINE A KEY SO THAT WHEN
IT IS PRESSED, AN ENTIRE WORD OR
PHRASE WILL BE PRODUCED.  THESE ARE
CALLED MACROS.

 1) FIRST PUSH THE KEY
 2) THEN ENTER THE MACRO. END THE MACRO
    WITH A RETURN.

QUIT BY ENTERING A SPACE FOR THE KEY.

127 MACRO POSITIONS AVAILABLE
KEY  (#3) -> MACRO CATALOG
120 MACRO POSITIONS AVAILABLE
KEY  (#16) -> MACRO PRINT
115 MACRO POSITIONS AVAILABLE
KEY

BEFORE WE SAVE THE TABLE THAT HAS BEEN
CREATED, HERE IS ONE FINAL OPPORTUNITY
TO MAKE A CHANGE.  ANSWER WITH Y OR N.

WOULD YOU LIKE TO ASSIGN MORE MACROS?
N

WOULD YOU LIKE TO SAVE THE KEYBOARD
TABLE THAT YOU HAVE CREATED?

PLEASE ENTER A NAME FOR THE FILE:
FILE NAME? DSK

FILE DSK IS NOW SAVED.
```

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Listing 3: *DSK-MACRO-KEYIN is a 6502 assembler program that replaces the Apple's normal KEYIN routine. It can be entered into an assembler but is short enough to be entered directly into memory from the Apple monitor. After entering the code, type in BSAVE DSK-MACRO-KEYIN,A$300,L$54 to save this file on disk.*

```
:ASM

                 1000 ******************************
                 1010 * KEYBOARD DRIVER ROUTINE
                 1020 *
                 1030 * BY: ROB WISEMAN
                 1040 *      JULY 7, 1982
                 1050 *
                 1060 ******************************
                 1070 *
                 1080        .OR $0300
                 1090 *          THIS PROGRAM WILL LOAD AT $300.
                 1100 *          IT REPLACES THE KEYIN ROUTINE
                 1110 *          ON A 48K APPLE II+.
                 1120 *
                 1130 INHOOK  .EQ $38
                 1140 KEYBOAR .EQ $C000
                 1150 KEYSTRB .EQ $C010
                 1160 ASHIMEM .EQ $74
                 1170 RNDL    .EQ $4E
                 1180 RNDH    .EQ $4F
                 1190 BASL    .EQ $28
                 1200 LOOK    .EQ $9500
                 1210 XSTOR   .EQ $955E
                 1220 MPOINT  .EQ $955F
                 1230 MACR    .EQ $955F
                 1250 *
                 1260 ******************************
                 1270 *
                 1280 SJAR
                 1290 *          BRANCH TO STARTUP
                 1300 *          ALLOWS FILE TO BE BRUN
0300- 18         1310        CLC
0301- 90 3B      1320        BCC STRUP
                 1330 *
                 1340 *****************************
                 1350 *
                 1360 DRIV
                 1370 *          THIS IS THE NORMAL ENTRY
                 1380 *          POINT.  FIRST SAVE THE X
                 1390 *          REGISTER. THEN FIND
                 1400 *          THE CHARACTER IN THE LOOK
                 1410 *          TABLE.  IF BIT 7 IS ON,
                 1420 *          SEND THAT TABLE ENTRY.
                 1430 *
0303- 8E 5E 95   1440        STX XSTOR       SAVE X REGISTER
0306- AE 5F 95   1450        LDX MPOINT      CHECK FOR MACRO MODE
0309- D0 1F      1460        BNE GETMAC      BRACH IF IN MACRO
030B- 48         1465        PHA             SAVE CURSOR CHARACTER
                 1470 KEYIN
030C- E6 4E      1480        INC RNDL        INCR RANDOM NUMBER
030E- D0 02      1490        BNE KEYIN2
0310- E6 4F      1500        INC RNDH
                 1510 KEYIN2
0312- AD 00 C0   1520        LDA KEYBOAR     KEY DOWN?
0315- 10 F5      1530        BPL KEYIN       NO INCR RND AGAIN
0317- 2C 10 C0   1540        BIT KEYSTRB     RESET STROBE
031A- 29 7F      1560        AND #$7F        BIT 7 OFF
031C- AA         1570        TAX
031D- 68         1575        PLA             GET OLD CURSOR
031E- 91 28      1576        STA (BASL),Y    REPLACE FLASHING SCREEN
0320- BD 00 95   1580        LDA LOOK,X      GET CHARACTER
0323- 10 04      1590        BPL AMACR       WAS IT MACRO?
                 1600 EXIT
                 1610 *                      NORMAL EXIT ROUTINE
0325- AE 5E 95   1620        LDX XSTOR       RESTORE X REGISTER
0328- 60         1640        RTS             RETURN
                 1650 *
                 1660 **********************************
                 1670 *
                 1680 AMACR
                 1690 *          USE THE LOOK TABLE RESULT
                 1700 *          AS A POINTER TO THE MACR
                 1710 *          TABLE.  SEND CHARACTERS
                 1720 *          UNTIL BIT 7 IS OFF.
                 1730 *
0329- AA         1740        TAX
                 1750 GETMAC
                 1760 *          GETMAC IS THE ENTRY POINT
                 1770 *          FOR A MACRO THAT IS NOT
                 1780 *          FINISHED.
                 1790 *
032A- BD 5F 95   1810        LDA MACR,X      GET NEXT CHARACTER
032D- 10 06      1820        BPL LASMAC      LAST CHAR IN MACRO?
032F- E8         1830        INX
0330- 8E 5F 95   1840        STX MPOINT      NO SET FOR NEXT
0333- 10 F0      1860        BPL EXIT        GET OUT
                 1870 LASMAC
                 1880 *                      THIS IS LAST CHAR
0335- 09 80      1885        ORA #$80        TURN ON BIT 7
0337- A2 00      1890        LDX #$00        ZERO OUT POINTER
0339- 8E 5F 95   1900        STX MPOINT
033C- F0 E7      1910        BEQ EXIT        GET OUT
                 1920 *
                 1930 *********************************
                 1940 *
                 1950 STRUP
                 1960 *          THIS CODE PLUGS THE KEYBOARD
                 1970 *          DRIVER ROUTINE INTO DOS 3.3
                 1980 *          IT IS ONLY RUN TO INTIALIZE
                 1990 *          THE KEYBOARD DRIVER PROGRAM
                 2000 *
033E- A9 95      2010        LDA #$95
0340- 85 74      2020        STA ASHIMEM     SET HIMEM
0342- A9 00      2030        LDA #$00        RESET VARIABLES
0344- 8D 5F 95   2040        STA MPOINT
0347- 85 73      2050        STA ASHIMEM-1
0349- A9 03      2060        LDA #DRIV       GET DRIVER ADDRESS
034B- A0 03      2070        LDY /DRIV
034D- 85 38      2080        STA INHOOK      PUT INTO HOOK
034F- 84 39      2090        STY INHOOK+1
0351- 20 EA 03   2100        JSR $3EA        CONNECT TO DOS
0354- 60         2110        RTS             ENDIT
                 2120 *********************************
                 2130 * $9500  LOCAL VARIABLES
                 2140 *********************************
                 2150 *
                 2160 * LOOK
                 2170 *          THIS IS WHERE THE LOOKUP
                 2180 *          TABLE BEGINS.  ENTRIES
                 2190 *          WITH BIT 7 ON ARE REAL
                 2200 *          CHARACTERS FOR OUTPUT.
                 2210 *          IF BIT 7 IS OFF, THIS IS
                 2220 *          AN INDEX INTO THE MACRO
                 2230 *          TABLE.
                 2270 *
                 2280 ***************************
                 2290 *
                 2300 * MACR
                 2310 *          MACRO KEY DEFINITIONS
                 2320 *          ARE STORED HERE BY TABLE
                 2330 *          BUILD PROGRAM.  IF THE
                 2340 *          LOOK TABLE ENTRY DOES NOT
                 2350 *          HAVE BIT 7 ON, THEN IT IS
                 2355 *          AN INDEX TO THE MACR TABLE.
                 2360 *          LAST CHARACTER IN MACRO
                 2370 *          WILL HAVE BIT 7 OFF.
                 2380 ******************************
```

Listing 4: *KEYSTART is a short program written in Applesoft BASIC. Its function is to initialize the system with the new keyboard table. It asks for the name of the keyboard table and then loads this from disk. Finally, it activates a BRUN of the new KEYIN routine.*

```
]PR#0
]LIST

1  HIMEM: 38144
5  HOME
10  PRINT " THIS PROGRAM WILL LOA
    D AND INITIALIZE"
20  PRINT "THE DSK-MACRO-KEYIN RO
    UTINE"
30  PRINT
40 D$ =  CHR$ (4)
50  INPUT "ENTER THE KEYBOARD FIL
    E NAME ";A$
60  PRINT D$;"BLOAD ";A$
70  PRINT D$;"BRUN DSK-MACRO-KEYI
    N"
```

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part stores macroinstructions. Once this table is created, the program will save it on disk. A sample run is included. The program logic is easy to follow; the only unusual feature is that the program adds a 0 character to the null string that the Applesoft GET statement returns for the SHIFT-CTRL-P key.

- DSK-MACRO-KEYIN: This machine-language routine (see listing 3) replaces the Apple's normal KEYIN routine in page three of memory. It receives values from the keyboard and looks up their replacements in the translation table. If the translation table indicates that a particular key has been assigned a macroinstruction, the new KEYIN routine sends the characters from the macroinstruction table.
- KEYSTART: This routine (see listing 4) loads the translation table and then activates the new KEYIN routine. This could be stored as a HELLO program on the boot disk.

It's easy to rearrange the key caps on the Apple to match new key assignments.

While experimenting with new key definitions, you may find it odd to be pressing a key marked with one character and have another character appear on the video screen. However, it is quite easy to rearrange the key caps on the Apple to match new key assignments. I discovered this recently after my 3-year-old had eaten a popsicle while playing typewriter—I had to pry off the key caps to rinse them. Only gentle pressure was required.

Both those who hunt and peck and trained keyboard artists will find the macroinstructions helpful. Wouldn't it be nice to hit CTRL-C and have the word CATALOG show up on the screen? Think how fast you could program in Applesoft BASIC if the CTRL-P combination produced the keyword PRINT and CTRL-I produced the word INPUT.■

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1. *ANSI X4.22-1983: American National Standard for Office Machines and Supplies—Alphanumeric Machines—Alternate Keyboard Arrangement.* New York: American National Standards Institute, 1983.
2. Glasco, David B., and Murray Sargent III. "Using IBM's Marvelous Keyboard." May 1983 BYTE, page 402.
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About the Author

Bob Wiseman (1899 Muskegon Dr., Cincinnati, OH 45230) designs financial modeling/information systems at Cincinnati Milacron and teaches microcomputing classes. He owns an Apple II Plus and is active in the Cincinnati Applesiders.

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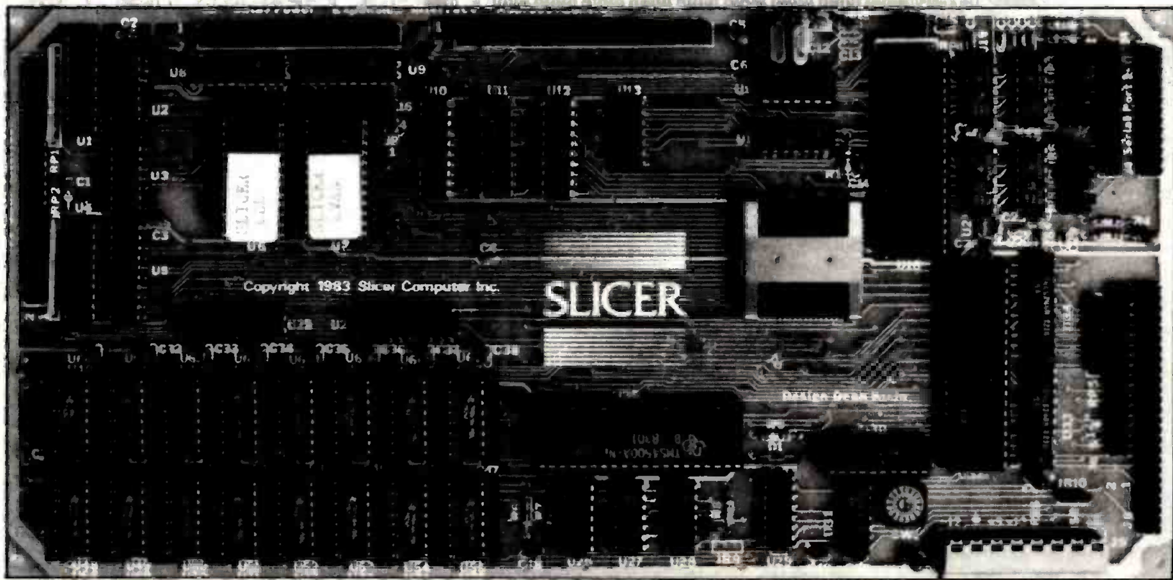

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The Handbook of Artificial Intelligence, Volume 1

Avron Barr and Edward Feigenbaum, eds.
William Kaufman Inc.
Los Altos, CA, 1981
409 pages, $30

Reviewed by
Henry W. Davis
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Dayton, OH 45435

The Handbook of Artificial Intelligence is a monumental compendium of information that will be a basic reference for people in artificial intelligence (AI) and related fields for some time to come. This three-volume series, more than six years in the making, combines contributions from over a hundred researchers in AI. Yet the style of editing provides a cohesiveness and homogeneity that make for fascinating cover-to-cover reading.

The stated goals of the treatise are "to present jargon-free explanations of AI programming techniques and concepts" as they were motivated historically and scientifically. It attempts to address professionals who are not specialists in AI nor even necessarily in computing. In the first volume, at least, these goals have been achieved.

Volume 1 covers search routines, knowledge representation, and understanding natural language—written and spoken. Volumes 2 and 3, which will be reviewed in future issues, cover the other main divisions of AI.

Organization within the chapters is "top-down." Each chapter starts with an article giving an overview of a major topic. Follow-up articles focus on key aspects of the problem. Most chapters conclude with several articles describing particular AI projects in detail, bringing the whole discussion down to earth. The articles naturally connect if you read the book from beginning to end—a fine way to obtain a general understanding of AI.

An important aspect of this series is the system of references and cross-references. You may go directly to a chapter of interest, where you will find references to other *Handbook* articles that clarify or elaborate on the topic at hand. Annotated references to outside literature cite sources that enlarge on basic ideas and research papers (up to 1980).

The list of chapter editors, contributors, and reviewers reads like a who's who in AI. Editor Edward Feigenbaum has pioneered in AI projects since the mid-1960s and is chairman of the Stanford Computer Science Department. Co-editor Avron Barr is a research associate in computer science at Stanford; he is involved in intelligent, computer-based instructional systems and the use of "meta-knowledge" in AI systems.

The *Handbook* editors have given careful attention to uniformity and comprehensibility. Overall, the quality and style are even. However, in a few places articles are not well connected. For example, articles II.D1 and II.D2 discuss automatic proving in propositional calculus in such a way that it's hard to relate them to each other. The articles are not equally easy to read; some of the overviews will be hard first-reading for the novice. At times the technology is so sophisticated that only its flavor can be given.

Search

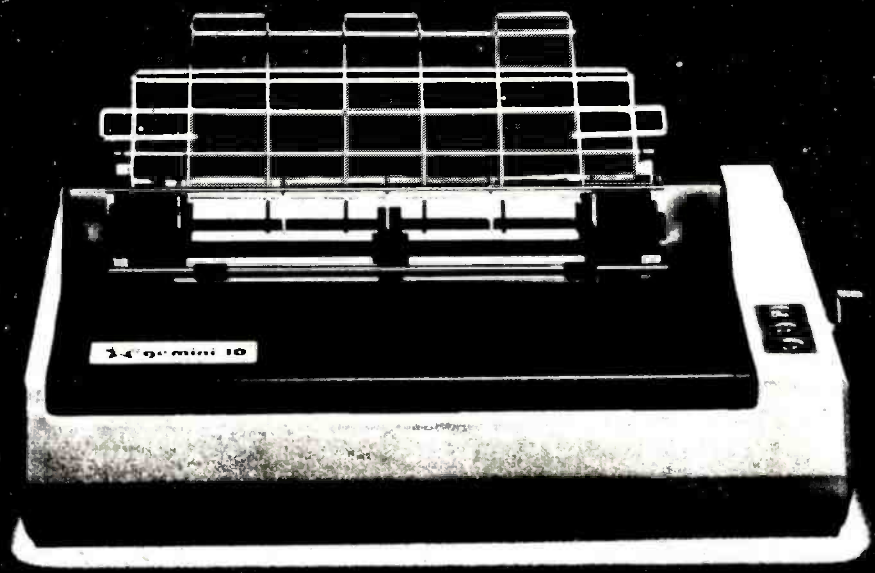
Search routines, described in Chapter II of the *Handbook*, are often a major component of AI problem-solving systems. For example, search techniques are used to look for the best move in skill games like chess or checkers. They are also used to prove theorems, to generate robot plans, and in a host of scientific applications.

State space searching is best described in terms of a simple puzzle. The *Handbook* uses a classic example—the 8-puzzle, shown in figure 1. The square array has eight numbered tiles and one vacant space. By sliding the tiles vertically or horizontally into the vacant space, you get different configurations or *states* of the puzzle. Figure 2 shows a typical start state and a number of states that can be obtained from it. Figure 3 shows a possible goal state. In working the puzzle, you *search* for the goal by moving the puzzle from the start state through a number of intermediate states. The moves, represented by the descending lines in figure 2, are called *operators*.

In the general situation, a problem is viewed as having a start state, a goal state, and a number of operators that are used to move the problem from one state to another. A search program attempts to move from the start state to the goal state by successive applications of the operators. In *blind* searches, the order in which potential solution paths are explored is independent of the problem domain. Such routines are not useful for hard problems due to a *combinatorial explosion:* they use up computer time and space resources before they find a solution. The most effective search techniques use domain-specific information in a heuristic fashion: the program compares intermediate states with the goal state and makes an informed guess as to which state is nearest. Paths passing through this conjectured near state are explored first. For example, in the 8-puzzle the program might conjecture that states with the fewest number of tiles out of place are the least number of moves away from the goal.

Another important search technique is *problem reduction*, in which problems are decomposed via operators into more easily solved subproblems. It is understood that, in order to solve the original problem, each of the subproblems must be solved. Subproblems are themselves further decomposed and the process continues until a solution situation is found. As before, blind searching is not effective, and heuristic methods have been developed. Several programs exemplify these techniques: Slagle's SAINT performs symbolic integration; Gelernter's geometry machine proves theorems in high school geometry; and Nilsson, Fike, and Sacerdoti have achieved impressive success in the area of robot planning.

Searching is the major component in current programs that play games like checkers, chess, or go. Such programs perform about as well as skilled humans in checkers, close but not as well in chess, and much worse in go. Moves are determined by searching part of a *game tree*, a structure that keeps track of potential future moves by the computer and its opponent. If the whole game tree were expanded, the computer could see all possible moves and would always win. However, for interesting games this is not feasible because it would result in a combinatorial ex-


gemini 10

plosion. Successful game-playing programs perform a search that involves many heuristics. One important area for heuristics concerns what portion of the game tree should be generated. Another concerns how to evaluate the board positions on the tree and translate this into a good move choice.

Knowledge Representation

Search strategies are a part of many problem-solving systems. But how does one represent the basic knowledge needed to implement these strategies? This is the concern of *knowledge representation*, the most active area of AI research.

A variety of knowledge-representation techniques is surveyed in Chapter III. Although parts of this material are available in other sources, no other current AI text has isolated and presented this information as a single coherent topic.

An early and still used method of representing knowledge in AI uses a language called *first-order predicate calculus*. Invented by logicians and mathematicians, this is a formal, flexible language ideal for representing precise information. Predicate calculus has several advantages. Automatic deduction mechanisms exist for information expressed in the calculus; AI systems using the calculus usually contain such "theorem provers." Other advantages are its clarity and the modularity of facts contained in a predicate calculus database. A big problem is that a combinatorial explosion occurs when today's theorem provers work with a large calculus database.

Production systems are a method of representing knowledge that has been very successful in scientific and engineering applications. Knowledge is represented via "situation-action" rules. These rules, or productions, have the form "if this condition is true, then take this action." A modern AI system using this approach may have hundreds of such rules in its database. A control system determines which rules are applicable to a problem state and chooses from among them. Essentially, productions act like operators. AI researchers have found that large amounts of useful human knowledge can be put into this IF. . .THEN format. Successful rule-based systems have been written in such diverse areas as medical diagnostics, mathematical discovery, and computer configuration design. Current research focuses on questions of rule structure and proper control design.

A number of fascinating knowledge representation constructs are illustrated in the work of Roger Schank and his colleagues. Articles in Chapters III and IV of the *Handbook* describe different aspects of Schank's research. His programs process sentences and stories written in "natural language" (the language people use when communicating to each other; for example, English or Chinese). His programs demonstrate understanding of what they have read by paraphrasing it, answering questions about it, or translating it into another natural language. For example, a program called SAM was presented with these sentences:

John went to a restaurant. He sat down. He got mad. He left.

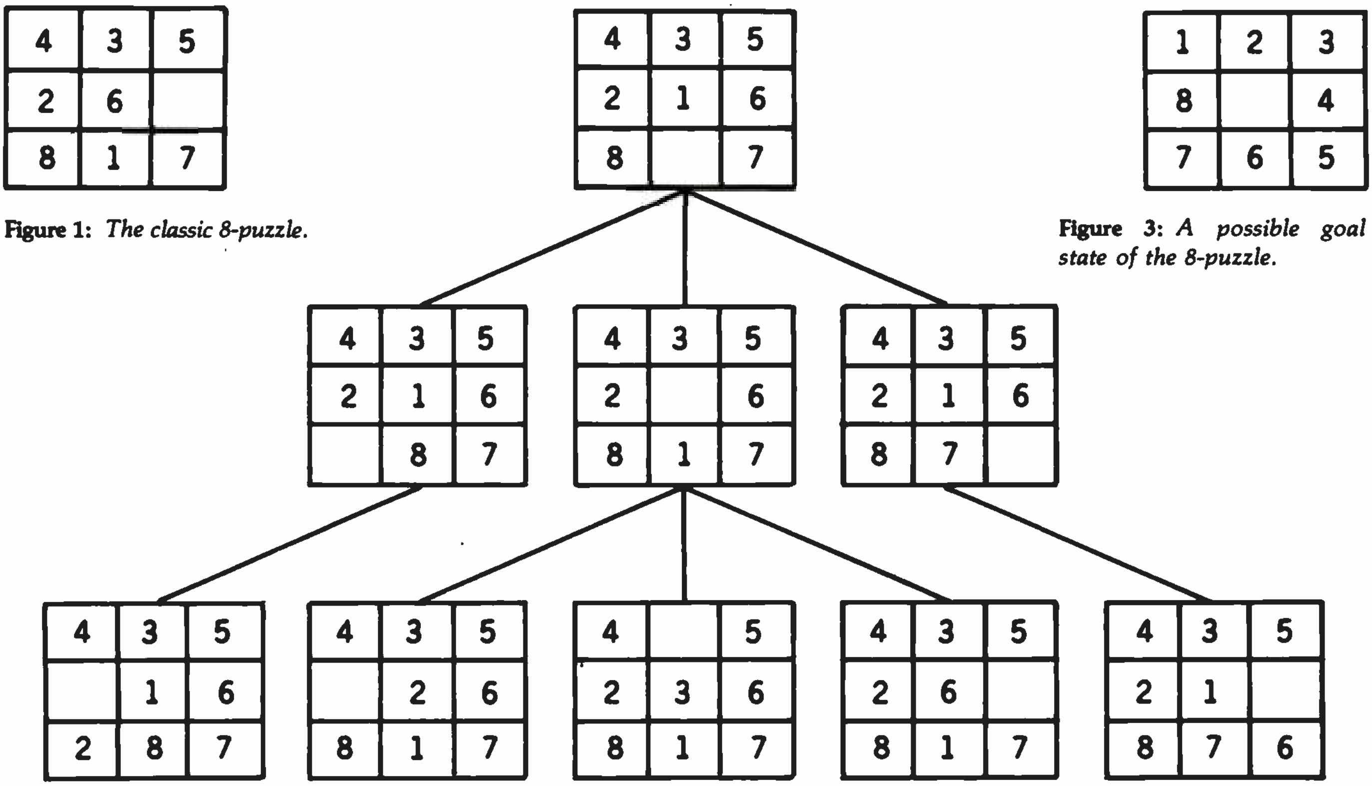
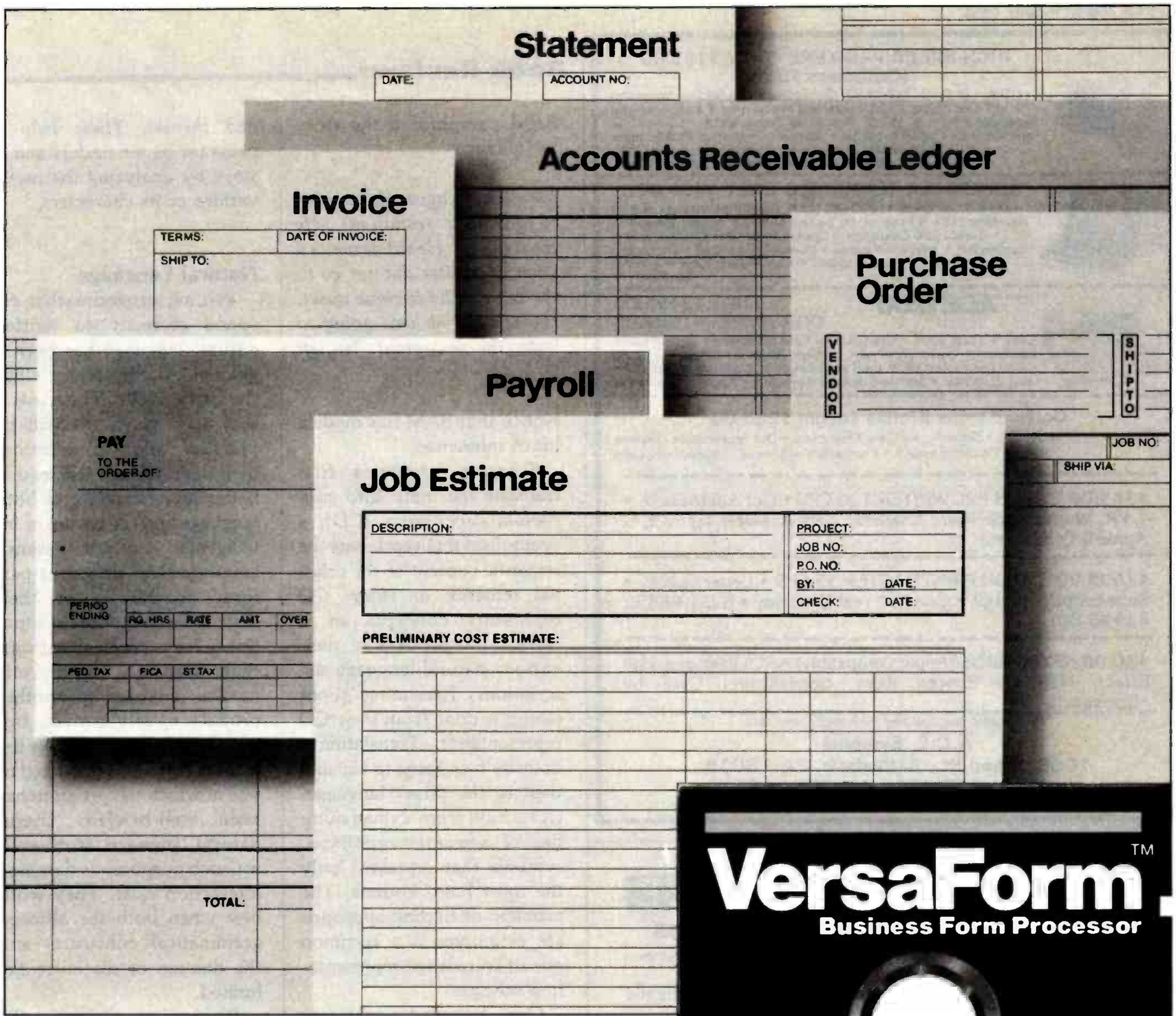


Figure 1: *The classic 8-puzzle.*

Figure 2: *A possible start state and several derivation states of the 8-puzzle.*

Figure 3: *A possible goal state of the 8-puzzle.*



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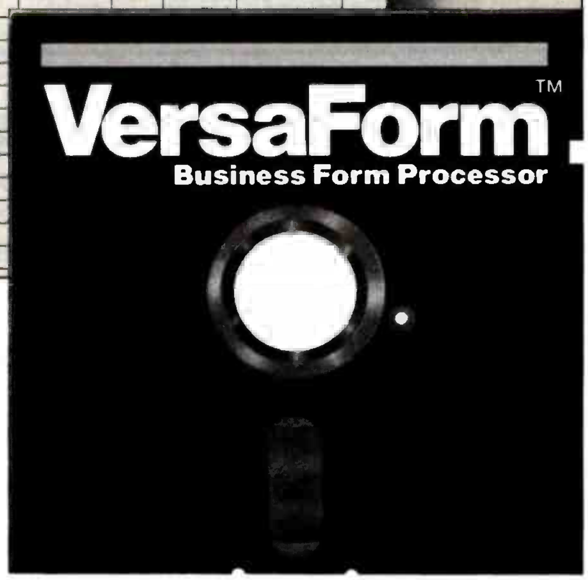

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Book Reviews

SAM paraphrased the story as follows:

John was hungry. He decided to go to a restaurant. He went to one. He sat down in a chair. A waiter did not go to the table. John became upset. He decided he was going to leave the restaurant. He left it.

Notice that SAM has made a lot of inferences.

Schank's programs first translate the input into *conceptual dependency* (CD), a symbolism that represents the semantic content of the original sentence or story. CD represents concepts in a fashion independent of their various natural-language descriptions. Reasoning about stories is done from their CD representation. Translating is done by first going to CD and then to the target language. CD is built from a small number of *semantic primitives*, symbols that represent only the most basic notions. The problem of finding appropriate primitives is a common one in knowledge-representation schemes.

One knowledge-representation device used by Schank's programs is called a *script*. This is a standardized sequence of events that describe some stereotypical human activity, such as going to a restaurant or visiting a doctor. The program tries to match a story fragment with a script, filling in script details from the story and defaulting information not in the story from the script itself. SAM used a restaurant script to help it "understand" and make inferences in the previous example. A variation of scripts, called *frames*, has been used by other researchers.

Scripts are not always adequate to understand stories. Schank has introduced other knowledge-representation structures called *goals*, *plans*, and *themes*. These help a program better understand a story by analyzing the motivations of its characters.

Natural Language

Writing programs that respond correctly to written natural language has been a goal of AI researchers since the early 1960s. The view is that such programs will be practical and, in addition, their development will lead to better understanding of both language and the nature of intelligence. Current natural-language (NL) programs perform acceptably, at their best, in limited domain situations. For example, programs that translate from one natural language to another produce mostly correct, but not elegant, output when the subject domain is restricted to one in which the program has been well briefed. Useful natural-language front-ends for such purposes as database interaction exist. They work best when both the allowed grammatical constructs and the domain of discourse are limited.

Parsing, or analyzing the grammatical construct of the input, is a basic aspect of NL processing. Input sentences are broken into such units as nouns, verbs, prepositional phrases, etc. This enables the *semantics* (i.e. meaning) of the sentences to be more transparent. The *syntax*, or grammatically allowed form of the input language, is specified by a set of rules called a *grammar*. There are many grammars, some suitable for natural languages and others only for programming languages, and many approaches to parsing. A very readable overview of this subject is presented in Chapter IV of the *Handbook*.

Approaches to NL processing are evolving rapidly. The first systems that could handle genuinely flexible English

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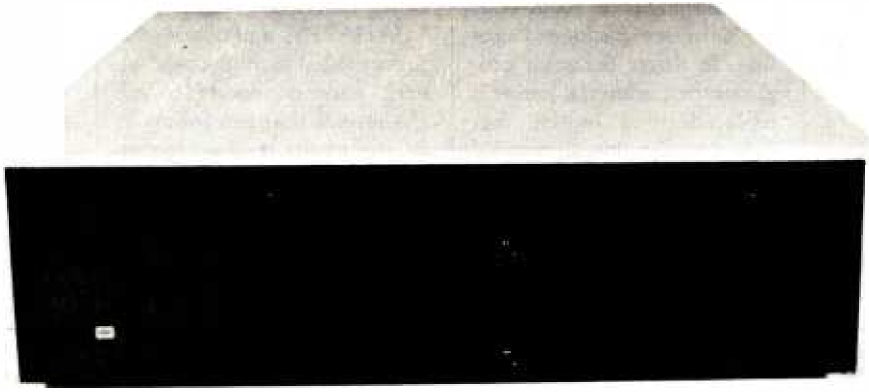

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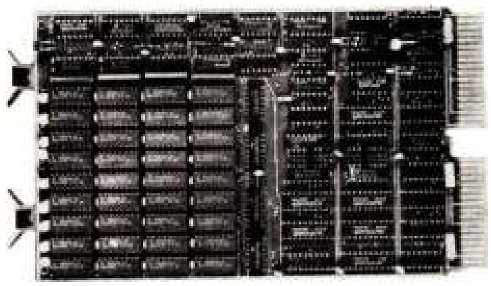

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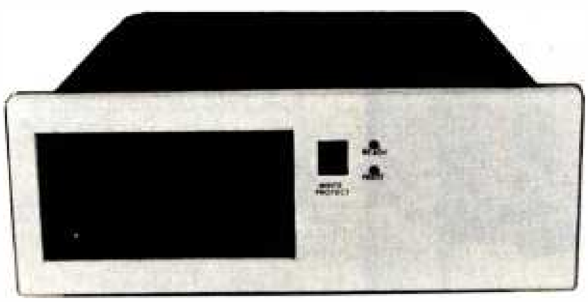

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in a limited domain were the LUNAR system of William Woods and SHRDLU by Terry Winograd, both developed in the early 1970s. In SHRDLU, for example, a number of features combined for success and pointed the direction for further research: parsing emphasized semantically meaningful units rather than the traditional grammatical ones, the parsing process itself manipulated data structures additional to the grammatical rules normally manipulated, and semantic routines aided in parsing so that syntax and semantics were no longer separate. SHRDLU had a great deal of knowledge about the discourse domain and used this knowledge during all phases of input processing. Separate articles in the *Handbook* detail SHRDLU, LUNAR, and other important NL systems.

Current directions in NL processing are described in the *Handbook* and illustrated by several systems. Semantic and syntactic analysis are increasingly merged. For example, in "semantic grammars" the semantic entities are moved directly into the grammar. LIFER, Hendrix's versatile system that provides natural-language front-ends for software packages, uses this. In Roger Schank's programs the traditional parser is replaced by a routine that converts the input directly into a semantic structure (CD) without using the usual theory of grammars. Knowledge-representation structures like frames and scripts make it possible for a program to use expectations in its processing of sentences. Knowing what is likely to be said, in light of what is being talked about and what has already been said, greatly reduces the number of possible meanings of a sentence. This is called *expectation-driven* processing.

Spoken Language

The *Handbook* describes major speech-understanding systems that came out during the mid-1970s. Many of the concepts of these programs are illustrated by the HARPY and HEARSAY systems, both written at Carnegie-Mellon University. In processing spoken language, a major problem is identifying words; connected speech signals do not look at all like the concatenation of signals of the individual words.

In HARPY, a network was precompiled with "sounds" at each node connected to all the sounds that can follow it in any of the legal sentences in the language. Interpreting an utterance corresponds to finding a path through the network representing a sequence of sounds that most closely matches the sounds in the utterance. The problem of finding the optimal path is a search problem to which heuristics were applied. HARPY worked fast and quite reliably but did pose problems: the precompiled network may require vast computer resources when the vocabulary is large; HARPY is relatively sensitive to missing acoustical segments and words because it does not take account of meaning to constrain search.

In HEARSAY, independent *knowledge sources* (KSs), routines that analyze phonetics, syntax, semantics and the like, looked at the speech signal and posted hypotheses about likely syllables, words and phrases on a global data structure called the *blackboard*. Hypotheses from lower-level KSs, about syllables and words, were examined for syntactic and semantic feasibility by upper-level KSs. Upper-level knowledge sources could also post on the blackboard suggestions about what words might be expected. Hypotheses were scored, and a scheduling routine expanded high-scoring hypotheses before low-scoring ones. Much of the processing is expectation-driven. This approach has proven fruitful.

HEARSAY has been a very influential program in AI due to its architecture. Its modularity allows different KSs and control strategies to be easily tested. The independence of the KSs allows for a parallel-processing version to be designed. The architecture has been used for several programs outside of speech understanding, for example crystallography, signal interpretation, and vision.

Conclusion

The AI community has been carrying on a dialogue with itself for 25 years. This needed book presents AI in perspective and makes it accessible to others in computing.■

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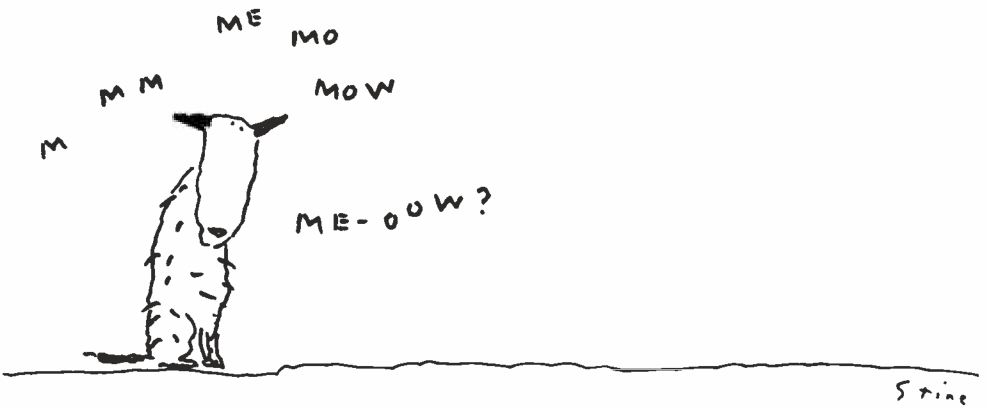

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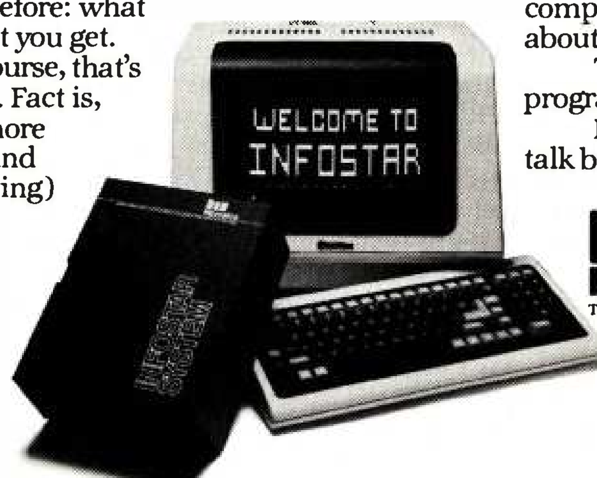

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The Practical EEPROM

For less than the price of an EPROM eraser, you can buy an EEPROM that doesn't need one

by Louis Wheeler

ROMs, PROMs, and EPROMs are quite satisfactory for many applications requiring nonvolatile memory. They perform best in those areas where the information they store is never, or almost never, changed. When the data must be revised, however, problems begin to arise. Because ROMs (read-only memories) and PROMs (programmable ROMs) cannot be reprogrammed, the old ones must be discarded and new ones programmed to replace them. EPROMs (erasable PROMs) such as the popular 2716 can be erased and then reprogrammed; however, the process is not as fast, easy, or inexpensive as one might wish.

For example, erasing the 2716 requires an ultraviolet light, and although really nothing more than a hopped-up fluorescent light bulb, it costs at least $70; fancy features such as timers increase the price. Considering the price of EPROMs on today's market—about $5—this eraser hardly seems like a wise investment unless you intend to reprogram a lot of EPROMs or make a lot of changes.

Then there's the cost of the EPROM programmer, a complicated piece of equipment that sometimes incorporates a microprocessor. Prices for this little gadget start at around $280. The total cost comes to about $355 just to put your system monitor in nonvolatile memory. And you must also consider software costs: special software is almost always required to program and verify EPROMs.

EPROM programming also takes time—a lot of time: time to create the software (or data) that goes into the EPROM and time to program the EPROM. It is also likely that you will need time to erase the EPROM (about half an hour), because it is inevitable that there will be a bug. After all, "to err is human," and programmers are only human. I have a monitor that I've used for several years that still has a bug in it. A small one, only one byte needs changing, but I don't have an eraser.

If costs, time, or complex circuits have kept you away from EPROM programming, hang tight, help is here in the form of an EEPROM (electrically erasable programmable read-only memory). An EEPROM (also abbreviated E^2PROM) can be erased without the hopped-up fluorescent light bulb; it doesn't even have to be removed from the circuit.

On-chip Timing

EEPROMs have been around for a number of years; however, the early ones were expensive, required a lot of trick circuitry, were slow for both read and write operations, and had other problems that prevented them from becoming a general replacement for the more popular 2716 EPROM. Now things are changing. Intel has introduced a new type-28XX family of EEPROMs. All of them feature fast access times of 250 nanoseconds (ns), which means they run at 4 MHz without the so-called wait states, plus improved erase and write times on the order of 10 to 50 milliseconds (ms). And like the 2716, they hold 2K bytes. However, all except one member of the family still require a great deal of support circuitry, some of it tricky. That one shining star in the family is the 2817 (see figure 1).

The 2817 stands out because the write-timing and pulse-shaping circuitry required by the others have been placed on-chip. The only external timing component is a single capacitor. And V_{PP} (programming voltage) is static, not pulsed by exter-

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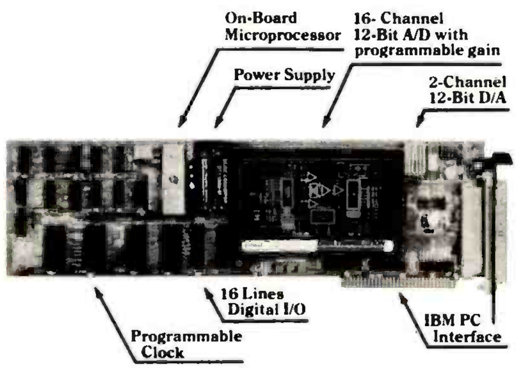

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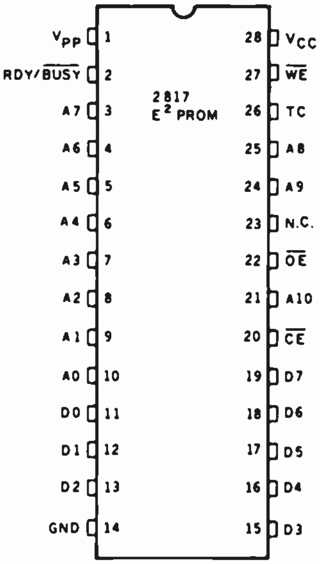

Figure 1: *Pinout specifications of the type-2817 EEPROM integrated-circuit package.*

nal circuitry. This feature cuts the support circuit requirements 70 to 80 percent.

Simplifying things further is the automatic-erase feature. No longer is it necessary to erase either the entire chip or a single byte before writing. The 2817 also has on-chip data verification to ensure correct programming. As a result, the software to program the 2817 is extremely simple—a move memory block does it. If you wish, you can program or reprogram a single byte, thus making patching that small bug a snap. Recently I completed a new system monitor. When the inevitable bug appeared, I was able to use the monitor's edit facility (while running in the EEPROM) to patch the monitor itself. Try that with a 2716 EPROM!

It's Not Perfect

If I sound enthusiastic about the 2817, it's because I am. However, there are a few things I don't especially care for: it uses a 28-pin package, which means you cannot simply rewire the old EPROM socket to accept the 2817. Write speed is quite slow compared to read; if write were as fast as read, the 2817 would more properly be called a RAM (random-access read/write memory), not a PROM. Also, there is a limitation on the number of times it can be reprogrammed: 10,000 times, meaning that your clock can't use it to store the time of day, but you certainly can maintain the current date. Entering the date once a day would take more than 27 years to exceed the reprogramming limitation. (The 2716 can be reprogrammed only 30 to 40 times.)

The limitation that bothers me most is the requirement for a +21-volt (V) static V_{PP}, a new voltage for most microcomputer systems. Fortunately, +21 V can be derived from the +5-V supply using a DC-to-DC converter. Several options for producing +21 V are discussed later.

The Circuit

The support requirements for a 2817 EEPROM are similar to those of the byte-wide static-memory chips. The S-100 design presented here (see figure 2) is slightly more complicated because of the added power-on/reset-jump circuit. The unit I constructed was an addition to an existing wire-wrapping board (containing two serial I/O [input/output] ports), thus simplifying construction through the use of existing power, bus buffers, and some spare gates. You might choose a similar approach or build the circuit from scratch using a prototype wire-wrapping board. While intended for the S-100 bus, it could be easily modified to accommodate other bus systems. All bus signals used are standard, with the possible exception of PHANTOM*. Some older memory boards do not have a PHANTOM* capability.

If the use of PHANTOM* is not possible in your system, or if the EEPROM is to be used for something other than a system monitor, the power-on/reset-jump portion of the circuit can be eliminated (IC6 and IC5A). The power-on/reset-jump can similarly be deactivated by removing IC6 from its socket. No switch has been provided. This deactivation is necessary until the EEPROM has been programmed with a monitor or boot loader. With IC6 installed, the power-on/reset-jump is enabled by a RESET* and disabled when the first I/O instruction is executed. Therefore, an I/O instruction, such as I/O port initialization, should appear early in the monitor program.

The location of the 2817 in memory has been set at hexadecimal F000 through F7FF. Other starting locations, although possible, would require some revision of the device-select circuit, IC7. The SINTA signal is required only if interrupts are used. If not, IC4B can be eliminated.

The RDY/BUSY* signal (IC8, pin 2) is an unusual one for a memory device. And it has nothing to do with reading data; it's used only during write operations. When commanded to write, the 2817 latches the address, data, and control signals. Then the RDY/BUSY* line goes low, pulling PRDY low, which causes the processor to enter a wait state until completion of the write operation. The time that the RDY/BUSY* signal is held low (typically 10 ms) depends on the external TC (timing capacitor), 5600 picofarad (pF) ± 10 percent, as specified by the manufacturer.

Producing +21 V

During write operations, the static V_{PP} is first used to erase the byte addressed and then to write the new data. The term static refers to the fact that V_{PP} is not pulsed as it is with EPROMs and other members of the EEPROM family. Although used only for write operations, chip logic requires that V_{PP} be held steady at +21 V during both read and write operations.

V_{PP} is specified at +21 V ± 1 V. If V_{PP} drops below +20 V, data retention is not assured; if it rises above +22 V, the EEPROM may be damaged. Being a nonstandard voltage, +21 V presents a problem. However, some microcomputer systems do have a +24-V supply, which with further regulation can be used to supply V_{PP}. If a +24-V supply is available, Intel suggests using a dropping resistor, a 22-V zener, and a 1N914 diode to derive the +21 V (see figure 3). Because my system does not have a +24-V supply, prior to constructing a more permanent +21-V source I used the zener-diode circuit (with a 330Ω resistor) and three 9-V transistor batteries connected in series

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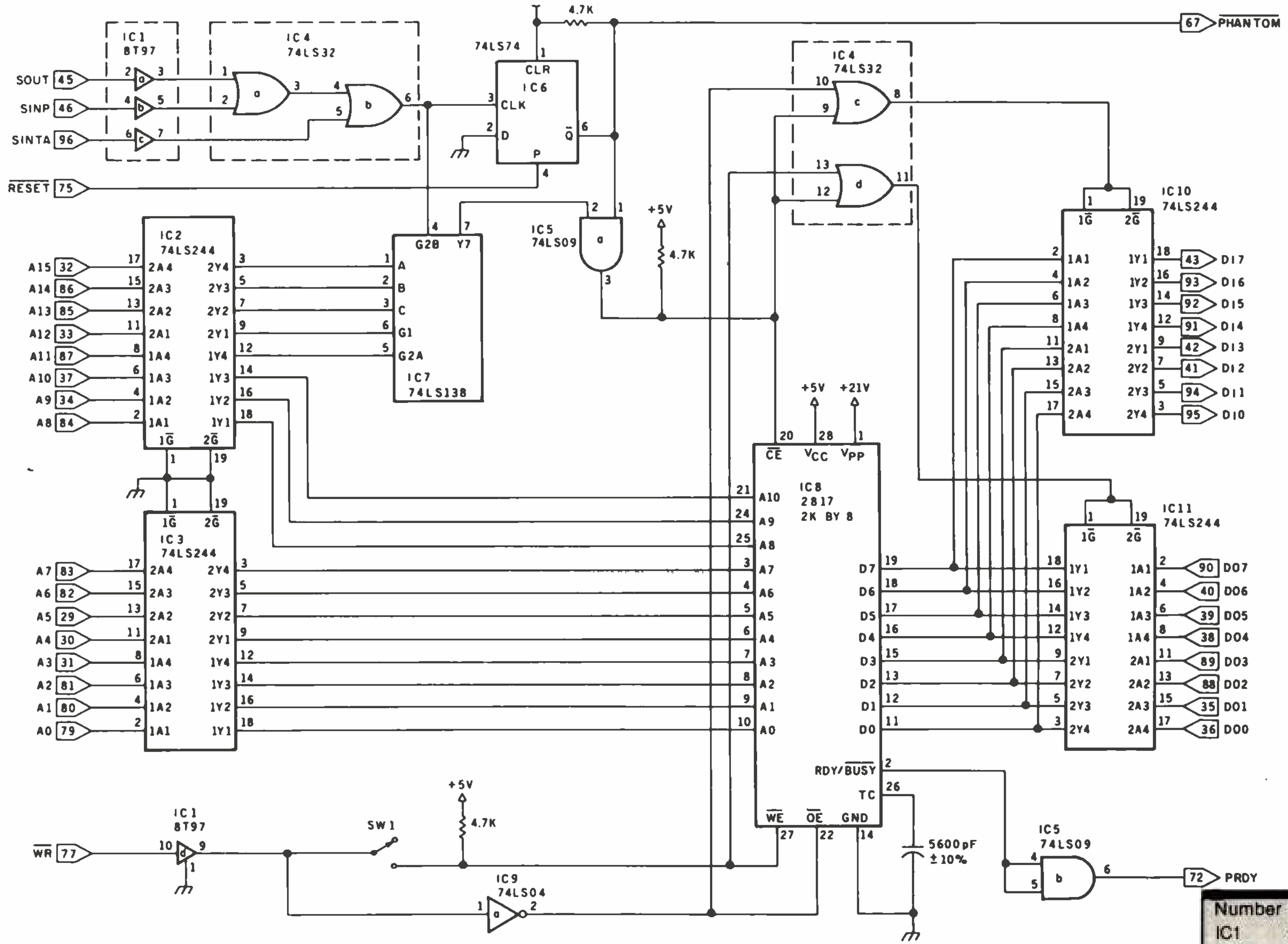

Figure 2: *A schematic of the 2817 EEPROM circuit. Intended for a system monitor, the circuit features power-on/reset-jump and write-protect circuits. Although designed for the S-100 bus, adaptation to other microcomputer bus systems should not be difficult.*

Number	Type	+5 V	GND	+21
IC1	8T97	16	8	
IC2	74LS244	20	10	
IC3	74LS244	20	10	
IC4	74LS32	14	7	
IC5	74LS09	14	7	
IC6	74LS74	14	7	
IC7	74LS138	16	8	
IC8	2817	28	14	1
IC9	74LS04	14	7	
IC10	74LS244	20	10	
IC11	74LS244	20	10	

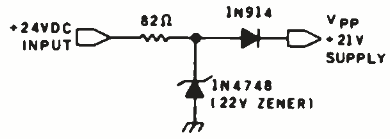

Figure 3: *The manufacturer's suggested circuit to adapt +24-V power supplies to provide the +21 V needed for V_{PP} (programming voltage).*

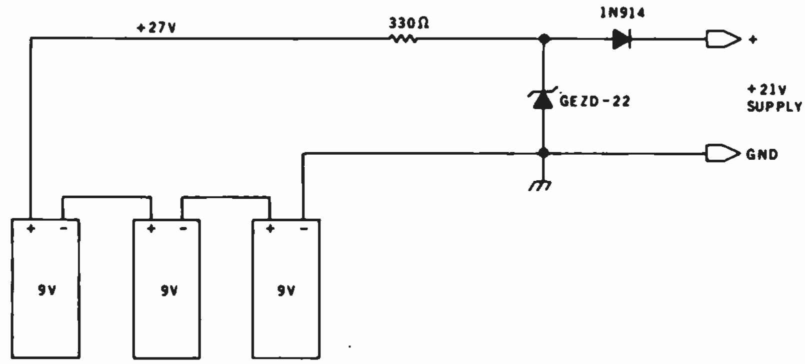

Figure 4: *A battery power supply for V_{PP} (+21 V) can be used for testing or until a permanent supply is constructed.*

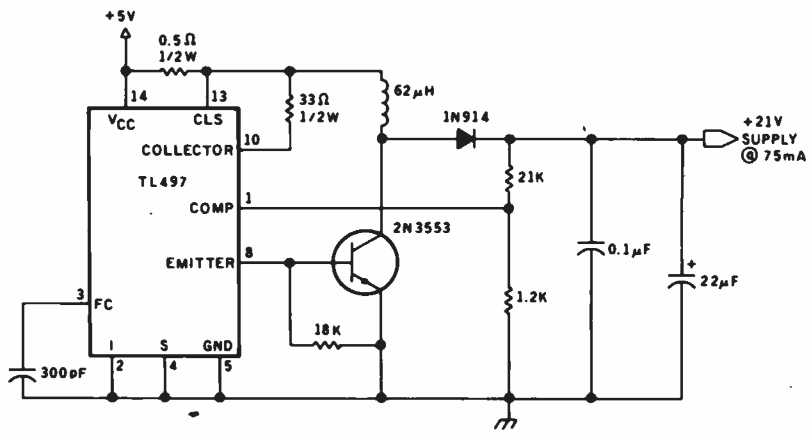

Figure 5: *A DC-to-DC switching-regulator power supply provides the +21-V programming voltage suggested by the EEPROM's manufacturer.*

(see figure 4). The current drawn by the 2817 is typically 8 milliamperes (mA) for read and 15 mA for write. The value of the dropping resistor can be computed using the following formula:

$$R = \frac{E_S - 22}{0.0165}$$

where E_S is the supply voltage. For example, if $E_S = 27$ V, then $R = (27-22)/0.0165 = 303\Omega$.

A careful check of the regulator output voltage would be a wise move because the 2817 can be damaged by overvoltage. Also, check to see that the 22-V zener is not overheating—if the value of the dropping resistor is too low, this condition can occur.

One other word of caution (here I quote the manufacturer's literature): "V_{PP} can only be applied after V_{CC} (+5 volts) is valid and WE* and CE* have been set to V_{IH} (high). While powering down, V_{CC} should remain valid and WE* and CE* remain at V_{IH} (high) until V_{PP} is less than V_{CC}. Failure to follow this sequence may result in data loss or device damage." This should not present a problem if the +21-V supply is derived from the +5-V supply. If you try the battery trick, however, do not forget to switch it off, or better yet, disconnect the battery prior to powering down tne system. I forgot once and got away with it, but it could have been a costly mistake.

Converting +5 V into +21 V is not too difficult. My old Cromemco 8K-byte Bytesaver does it with three transistors and a few other components. Intel suggests a more modern approach using a switching regulator (TL497 in figure 5) that produces +21 V at 75 mA, more than enough for this project. For more information on DC-to-DC converters, see references 2 and 4.

Construction of the EEPROM circuit is not difficult; using wire-wrapping techniques, it should take only a few evenings of effort for those with previous experience. Parts layout is not critical. The use of bypass capacitors (not shown on the schematic) near power connections is recommended. If the leads to the timing capacitor are small enough, one lead can be wrapped directly onto the socket pin and the other to any convenient ground pin.

Programming the 2817

Programming the 2817 is simple. I used my disk operating system to transfer the data (the previously assembled monitor) from disk to an unused area of memory. Then I used the operating system command MOVE to put the data into the 2817. It is not possible to make a direct disk-to-EEPROM transfer with most disk systems because of the device's relatively slow write speed. A simple BASIC program using PEEK and POKE commands also can do the job. Listing 1 is an example of such a program. Before beginning the write operation, turn SW1 on; after writing, turn SW1 off. When in the off position, SW1 prevents inadvertent writing into the EEPROM. For example, my system monitor searches for top of memory by rewriting every possible memory location; leaving SW1 on could cause rewriting of the EEPROM every time I power up. Most BASICs do the same thing. If allowed to happen, this rewriting

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Listing 1: *A simple BASIC routine programs the figure 1 EEPROM by moving data from RAM to the EEPROM.*

```
100 REM =====  EEPROM PROGRAMMER ====
110 REM
120 REM     D = Starting address of data
130 REM         to be programmed.
140 REM     N = Number of bytes to move.
150 REM     P = EEPROM starting address.
160 REM
170 LET D=32000  : REM For example only.
180 LET N=2048   : REM A full 2k.
190 LET P=61440  : REM F000 Hex.
200 REM
210 FOR A=D TO D+N
220       B=PEEK(A)
230       POKE P,B
240         P=P+1
250 NEXT A
260 REM
270 PRINT "DONE"
280 STOP
290 END
```

would unnecessarily shorten the life expectancy of the device.

Conclusion

Although my objective in this project was to provide nonvolatile storage for my system monitor, the 2817 is also ideal for storing price lists, accumulated totals, frequently used functions, keyboard character codes, printer/video display character fonts and graphics symbols, data-logging results, or any other infrequently changed data you want to maintain in high-speed nonvolatile memory.

The price of the 2817 might be considered somewhat high at $62.75. When you subtract the cost of an EPROM eraser, however, the price becomes a bit more palatable. The estimated cost of this project is around $110. To construct a similar circuit using a 2716, plus the cost of an EPROM eraser, would come to roughly $125. (A comparison of commercially available products is not possible because no 2817 boards are yet available.) Use of the 2817 then results in a net savings of about 10 percent over the 2716. However, more important than the monetary consideration are the savings in time and frustration. The 2817 has made EEPROM circuit design, construction, and usage simple, easy, and practical. ■

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About the Author

Louis Wheeler is a retired federal government employee. He spent 14 years as a programmer, teacher, and manager of minicomputer systems. His special interest is data processing, in which he has an associate degree. He can be contacted at 1323 Tamera Dr., Oceano, CA 93445.

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Alcor Pascal and Advanced Development Package

by Rowland Archer Jr.

TRS-80 owners now have a choice between two fine implementations of Pascal: Pascal-80, which I reviewed for BYTE in the December 1981 issue ("Pascal-80," page 304), and Alcor Pascal, the subject of this review. In addition to running on the TRS-80 Models I and III, Alcor Pascal runs under CP/M. (I did not test the CP/M version, but most of the comments in this review should also apply to it.)

System Overview

Alcor Pascal for the Model I comes on three single-density, 35-track disks with no operating system. The Model III version fits on two double-density disks. Two disk drives and 48K bytes of RAM (random-access read/write memory) are recommended. Limited use could be made of Alcor Pascal with one drive, but I think you would find this too restrictive.

Alcor Pascal owners may also purchase the Advanced Development Package (ADP). Supplied on a single disk, the programs in this package can make a compiled Pascal program smaller and sometimes faster.

Table 1 lists and describes the files you get with both Alcor Pascal and the ADP. Disk 1 also includes PATCH/CMD, a utility program supplied by Alcor. You need to install some patches before using Alcor Pascal with Apparat's NEWDOS/80 disk operating system on the Model I. Model III users get a set of patches for Logical Systems' LDOS disk operating system.

I used Alcor Pascal successfully with NEWDOS/80, LDOS, and TRSDOS on the Model I.

The Alcor system has four main components: a full-screen text editor, a Pascal compiler, a stand-alone run-time system, and a linking loader. The linking loader lets you construct a program in small modules that can be compiled separately. When you modify a program, only the changed modules have to be recompiled. The linking loader combines all the modules into one command file (with a /CMD *filename* extension) that can be run directly from the TRSDOS READY prompt.

Alcor does not demand a royalty for the sale of compiled programs, a welcome departure from the policy taken by many compiler vendors. Programs compiled by Alcor Pascal are portable from one type of computer to another: the same program will run on the Model I, III, and CP/M systems. You must use the run-time system for the target machine, but you do not have to make any changes to your source code. If your programs use specific hardware features of one system, they may need to be modified to run on another. One likely problem is the conversion of the TRS-80's 64-column by 16-line screen format to the 80-column by 24-line screen format of many terminals used with CP/M.

Language Features and Restrictions

Alcor's implementation of Pascal is complete. The only omissions from "standard Pascal" (as defined by K. Jensen and N. Wirth's *Pascal User Manual and Report*, New York: Springer-Verlag, 1975) are the GET and PUT

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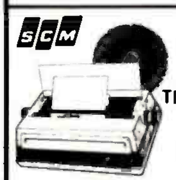

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Alcor Pascal Development System Disk 1:

File	Size*	Description
CMD/HELP	1	Editor command-help messages
ED/CMD	20	Full-screen text editor
ERRORS/DAT	3	Error messages for compiler
HELP/HLP	1	Editor summary-help messages
KEY/HLP	2	Editor control-key-help messages
PASCAL/CMD	28	Pascal compiler (nonoverlaid)
RUN/CMD	12	Run-time software

*Size in grans, one gran = 1280 bytes

Alcor Pascal Development System Disk 2:

File	Size	Description
LINKLOAD/CMD	9	Linking loader program
PASCAL/OV1	3	Compiler overlay
PASCAL/OV2	6	Compiler overlay
PASCAL/OV3	5	Compiler overlay
PASCAL/OV4	10	Compiler overlay
PASCALB/CMD	8	Overlayed Pascal compiler executive
STRINGS/OBJ	6	String library, object code
STRINGS/PCL	2	String library, declarations
TRSLIB/OBJ	4	TRS-80 library, object code
TRSLIB/PCL	2	TRS-80 library, declarations

Alcor Pascal Development System Disk 3:

File	Size	Description
DATABASE/PCL	12	Example Pascal program
PATCH/CMD	9	System patch program for updates
Txx/PCL	29	24 files with example Pascal programs from the tutorial manual (xx = manual page number)

Advanced Development Package Disk:

File	Size	Description
ADP/PAT	1	ADP patches for NEWDOS
BENCHMK/PCL	1	Example benchmark program
CODEGEN/CMD	18	Z80-code generator
CODEINIT/DAT	5	Data used by CODEGEN/CMD
OPTIMIZE/CMD	14	Pascal p-code optimizer

Table 1: *Files included with Alcor Pascal for the TRS-80 Model I and with the Advanced Development Package option.*

Function	Description
LEN	Length of a string
LEFT$	Left-hand portion of a string
RIGHT$	Right-hand portion of a string
MID$	Any portion of a string
STR$	Fill a string with specified character
ENCODEI	Convert integer to a string
ENCODER	Convert real number to a string
ENCODED	Convert double-precision number to a string
DECODEI	Convert string to an integer
DECODER	Convert string to a real number
DECODED	Convert string to a double-precision number
CHARACTER	Extract character from a string
CMPSTR	Compare two strings
CONC	Concatenate two strings
CPYSTR	Copy a string
DELETE	Delete characters from a string
FIND	Locate one string within another
INSERT	Insert one string into another
REPLACE	Overlay part of one string with another

Table 2: *String library functions included with Alcor Pascal.*

file buffer procedures and the capability to pass procedures and functions as parameters to other procedures or functions. Alcor Systems has done a fine job in implementing this complete version of Pascal in only 48K bytes of memory. Even better, everything seems to work.

Alcor supplements standard Pascal with a comprehensive library of functions (written in Pascal) for creating and manipulating character strings (table 2). Although the functions are quite powerful, I found them somewhat awkward to use. You can declare a variable to be of type STRING, but you must use the string library functions for everything, even simple operations such as assigning a value to a string and comparing two strings for equality. For example, suppose you have a string variable named REPLY that contains a user's keyboard response, and you want to see whether the user typed "QUIT." You must code:

```
QSTRING := BLDSTR('QUIT');
IF CMPSTR(QSTRING,REPLY)=EQUAL THEN
    WRITELN ('Goodbye!');
DISPOSE(QSTRING)
```

Compare this to the equivalent BASIC code:

```
IF REPLY = "QUIT" THEN
    PRINT "Goodbye!"
```

Alcor Pascal strings are built in a part of memory called the "heap." Every string has a current length associated with it, as many as 32,767 characters (this maximum is unusually large—many languages limit you to 255-character strings). When you create a string using the BLDSTR (build string) function, space for the string is allocated in the heap. If you do not call the DISPOSE function after you are finished with the string, the heap space is never recovered.

Alcor Pascal provides a good interface between machine-language routines and Pascal programs. A CALL$ function lets you load initial values into any of the Z80 registers and then pass control to a machine-language routine at a fixed address. Machine-language routines can be loaded into high memory, and all parts of the Alcor system honor the reserved high-memory pointer maintained by the disk operating system. Functions are available to get the address of any Pascal variable at run time, and details about their internal storage structure are provided so your machine-language routines can manipulate Pascal variables.

Alcor Systems included a set of functions to let TRS-80 users take advantage of specific hardware features (see table 3). Pascal programs using these functions may not be compatible with non-TRS-80 Alcor Pascal environments.

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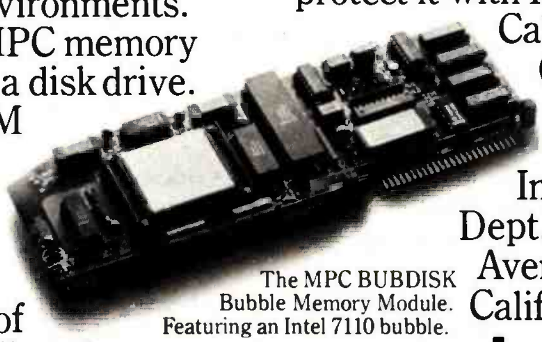

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At a Glance

Name
Alcor Pascal and Advanced Development Package

Type
Pascal language-development system

Distributor
Alcor Systems
800 West Garland Ave., #204
Garland, TX 75040
(214) 226-4476

Price
Pascal development system (includes text editor), $199; text editor alone, $60; Advanced Development Package (requires development system), $125

Software
Development system includes a full-screen text editor, Pascal compiler, run-time software, linking loader, and example programs. Advanced Development Package contains a p-code optimizer and a Z80 native-code generator

Format
For TRS-80 Model I and III: 5¼-inch floppy disks, single density, no disk operating system; for CP/M: contact Alcor for available disk formats

Computer
TRS-80 Model I or III, or Z80-based CP/M system; at least 48K bytes of RAM and one disk drive, two recommended

Documentation
245-page manual in three-ring loose-leaf notebook; contains comprehensive discussion of language details and system operation. Also includes a beginner's guide and a tutorial; some familiarity with programming is expected

Audience
Programmers in need of a Pascal language-development system for the TRS-80 Model I or III or a Z80-based CP/M computer

Disk Data Files

One of standard Pascal's widely acknowledged limitations is the restriction of data-file access to sequential I/O (input/output). Most Pascal implementations extend the language with some mechanism for random file access. Alcor has recently updated its Pascal with procedures to support random file access in addition to sequential-file access.

Alcor Pascal lets you specify filenames at run time. When a program starts, you are prompted to supply a filename for each file used by that program. You can link any file to the screen, printer, a disk file, or a "dummy" file. Output to the dummy file is simply discarded. If you don't want the system to prompt for filenames in this fashion, you can handle the process from within your Pascal program.

Another convenient feature is the ability to handle disk I/O errors in your program. For example, if a program tries to open a nonexistent file, you can catch this error within the program and continue processing. One thing missing in the file area is the ability to delete a file from within a program.

Procedure or Function	Description
CLEARGRAPHICS	Clear screen with graphics blank (80 hexadecimal)
SETPOINT	Turn on graphics pixel
RSETPOINT	Turn off graphics pixel
TESTPOINT	Test if graphics pixel is on or off
PEEK	Read 1 byte of memory
POKE	Write 1 byte of memory
GOTOXY	Position cursor on screen
NOBLANK	Control blanking of next screen line when printing a carriage return
READCURSOR	Return current cursor position (row, column)
WRITECH	Write single character at cursor
WRITESTRING	Write portion of string at cursor
CLEARSCREEN	Clear screen with blanks
INKEY	Strobe keyboard, return key if pressed
GETKEY	Return key when pressed
INP	Read a Z80 port
OUT	Write to a Z80 port
USER	Call a machine-language routine, pass one 16-bit integer in HL register pair
CALL$	Call a machine-language routine, pass values in all registers
TIME	Return time of day
DATE	Return date

Table 3: *TRS-80 library functions included with Alcor Pascal.*

Command	Description
APPEND	Read text from file into memory buffer
EXIT	Save file and end edit session
FIND	Search for string
HELP	List editor instructions
HSCROLL	Control horizontal scrolling
INSFILE	Insert lines from a file at the cursor
QUIT	Discard changes and end edit session
QUOTE	Insert nonprintable character(s)
REPLACE	Find string and replace with new one
ROLL	Set page size for vertical scrolling
SHOWFILE	List portion of any disk file
SHOWLINE	Move cursor to specified line number
TABS	Set tab stops
WRITE	Write text from buffer to disk file
+	Move cursor ahead specified number of lines
–	Move cursor back specified number of lines

Single keystroke commands are available to:
- Move cursor anywhere on screen
- Scroll back and forth a page at a time
- Delete and insert characters and lines
- Set automatic indenting
- Set and clear tabs, tab backward or forward
- Split, merge, and duplicate lines
- Repeat last FIND or REPLACE command
- Show amount of memory available

Table 4: *Commands provided by the Blaise full-screen text editor.*

Full-Screen Editor

The Alcor system includes a full-screen text editor (which may be purchased separately), called Blaise after Blaise Pascal. Although this editor has a number of powerful features, it has some annoying aspects that kept me from using it. Fortunately, Alcor Pascal source files

are in the normal TRS-80 ASCII (American National Standard Code for Information Interchange) file format. You can use any editor that lets you create and modify such files.

The Blaise editor does have some useful functions: a HELP command, a fast string-search command, the ability to list one file while editing another, the ability to insert a file (or portion thereof) into the file you are editing, and automatic tabbing to help enter properly indented Pascal programs (table 4).

My dissatisfaction with Blaise stems from Alcor's decision to make this editor independent of TRS-80 hardware characteristics so that it can run on CP/M systems as well as the TRS-80. This is a fine goal, but a side effect is that Blaise does not fit the TRS-80 hardware very well. For example, it uses the Model I Clear key as a control key. But you cannot hold Clear down to repeat a command. Therefore, to tab forward twice, you must press Clear-T-Clear-T. This problem occurs with many other control key functions, and I found it maddening enough to keep me from using Blaise.

Blaise allows you to edit a file too large to fit in memory all at once. To do this, you must use explicit commands to write some of the front of the file out to disk and append more of the file from disk to the memory buffer. Once you have written part of a file out to disk, you cannot return to editing that part of the file without finishing the edit session and starting over from the beginning.

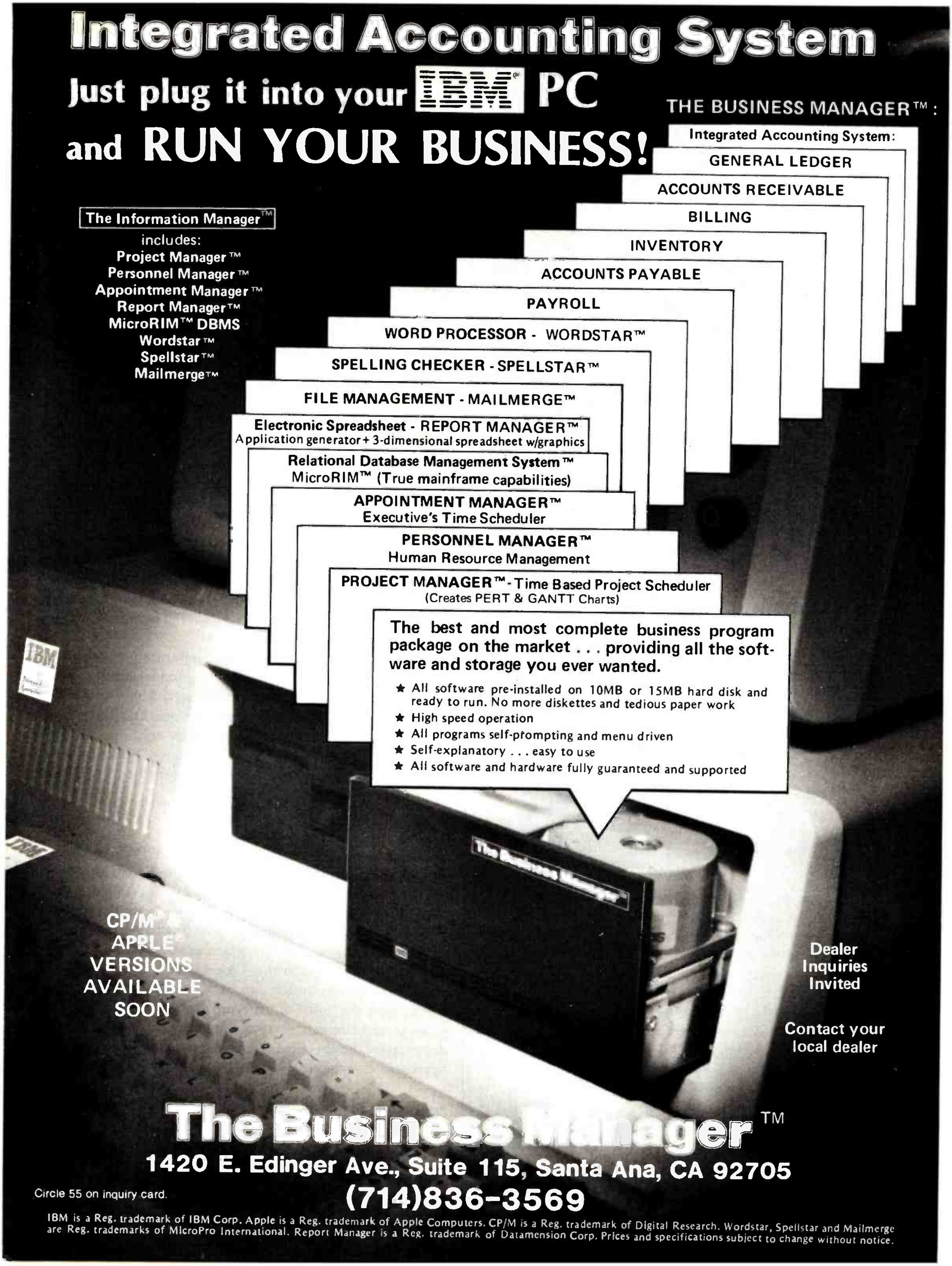
The CP/M version of Alcor Pascal comes with Blaise II, a more sophisticated editor that includes word-processing features such as justify, fill, cut, paste, and a complete macroinstruction language capability. I did not have an opportunity to test this version of Blaise.

Using the Compiler

Alcor supplies two versions of the compiler: one that loads into memory all at once and one that loads several overlays from disk as it compiles. The overlaid version runs more slowly but takes up less room in memory and thus compiles larger programs. Alcor claims that on a 48K-byte TRS-80, the nonoverlaid compiler can handle around 1000 lines of Pascal, whereas the overlaid compiler can process 4000-line programs. These numbers are only approximate and are highly dependent on what the lines contain.

The compiler reads its source code from disk and creates an object-code file on disk. The nonoverlaid compiler runs at around 100 lines per minute. It generates a program listing that can go to the screen, printer, or a disk file. Source-code errors are flagged with an arrow and one or more error numbers. Messages corresponding to the error numbers are printed at the end of the listing. Most of the error messages effectively point out the problem. Compiler options include:

•*Conditional compilation*. Any section of source code can be bracketed by conditional statements. If a statement is true, the bracketed code is compiled; otherwise it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•*Separate compilation*. A "nullbody" declarative, which takes the place of the main program statement, is used to create separately compiled procedures and functions that can be linked to form an executable program. One limitation is that separately compiled modules cannot access global variables unless *all* such modules have completely identical global variable declarations. In a big program, this can mean a lot of duplicate source code, slowing down the compilation process and defeating the purpose of separately compiled modules.

•*Double-precision variables*. A "double" declaration makes all REAL-type variables double precision. The default is single precision. The disadvantage with this is that you may frequently want to choose double precision for only selected variables. The TRS-80 version of Alcor Pascal saves some space in generated code by using the BASIC ROM (read-only memory) routines to do arithmetic.

Linking Loader

Of the two ways to run your program, the easier approach is to type "RUN *filename*," where *filename* is the name of your program. You can use this only if your program was compiled in one piece. The Alcor RUN program interprets p-code (pseudocode), the output of the Pascal compiler. P-code is the machine language for an imaginary machine, designed specifically to execute Pascal programs. A p-code interpreter is a program that runs on your hardware and simulates the operation of the imaginary p-code machine.

If your program contains separately compiled modules, you must run the linking loader utility. The loader requests the names of all separately compiled modules. It reads them into memory one at a time and produces a single /CMD file, which contains all the modules' code plus the p-code interpreter. You can then run your program by typing the name of the /CMD file from the TRSDOS READY prompt.

Advanced Development Package

The optional Advanced Development Package helps make Pascal programs more compact and/or faster (see table 1). ADP includes a p-code optimizer that transforms the code generated by the compiler into a smaller, equivalent program. According to Alcor, the optimizer usually reduces a program in size by 10 to 30 percent. Most of the programs I tried it on were reduced by about 20 percent, which can be a critical savings if you are pushing the limits of program size. An optimized program is sometimes faster too, but the increase in speed depends on the specific program. To achieve its aims, the optimizer does several things to a p-code file, including:

•replacing 2-byte addresses with 1-byte addresses where possible
•eliminating instructions that cancel each other out, such as increment followed by decrement
•replacing constant expressions with constants

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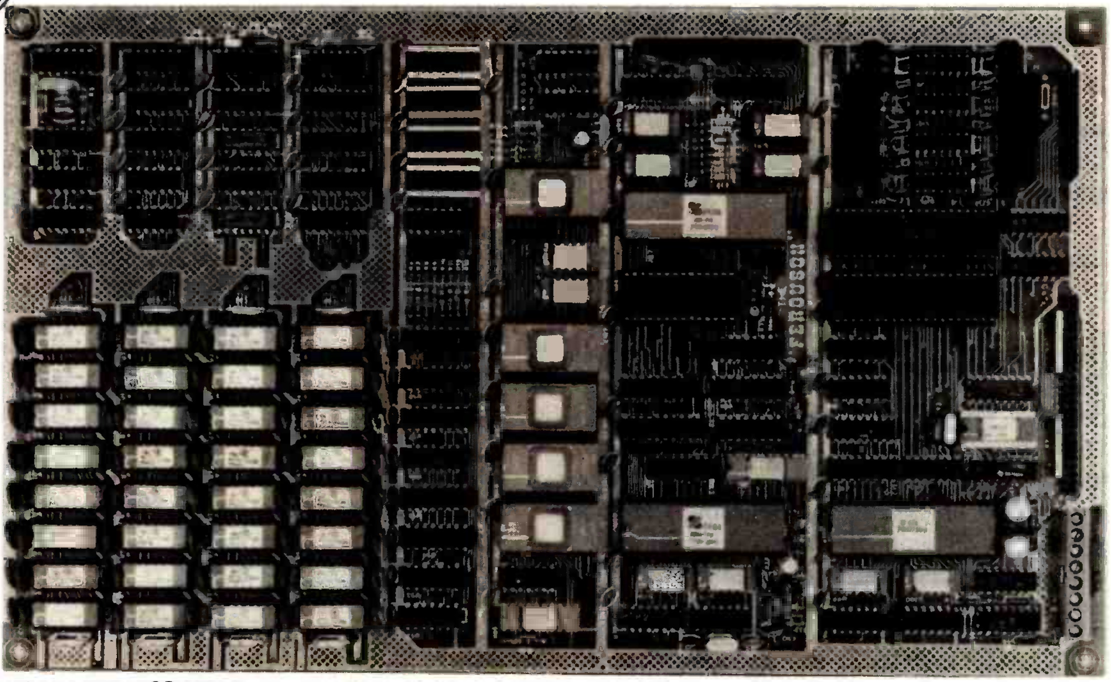

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	Compile Time	Run Time	Code File Size	Stand-alone /CMD Size
Alcor Pascal	0:45	6:39	1019	11307
Optimized	0:31	6:43	832	11269
Z80 Code	1:03	1:54	2677	11865
Pascal-80	0:08	23:34	512	11776

*Times are *minutes* : *seconds*; file sizes are in bytes

Table 5: *Benchmark comparison of Alcor Pascal with Pascal-80. Also listed are the compile times for optimized and code-generated Alcor Pascal.*

The ADP also includes a code generator that produces optimized Z80 code from a p-code file. Actually, the generator does not produce pure Z80 code; it leaves as p-code functions that will not benefit much from conversion. You still need to link the run-time package with the generated code to get an executable program. The code generator produces a Z80-code file that is typically 2 to 3 times larger than the corresponding p-code file but runs 3 to 5 times faster.

The ADP is noteworthy for its flexibility. A single program can contain all three types of code files: normal p-code files produced by the compiler, optimized p-code files, and Z80-code files from the code generator. The linking loader combines all three file types into a single /CMD file. This feature lets you select those parts of a program that will most benefit from increase in speed and run the code generator on them.

Performance

I ran several benchmark programs comparing Alcor Pascal and Pascal-80 on the TRS-80. In general, Pascal-80 compiles programs faster, but programs compiled by Alcor Pascal run faster. Listing 1 contains an example I borrowed from the article "A High-Level Language Benchmark" by Jim Gilbreath (September 1981, page 180).

Listing 1: *Eratosthenes Sieve high-level language benchmark program.*

```
PROGRAM prime;

CONST
    size = 8190;

VAR
    flags : ARRAY[0..size] OF BOOLEAN;
    i,prime,k,count,iter : INTEGER;

BEGIN
    WRITELN('10 iterations');
    FOR iter := 1 TO 10 DO
        BEGIN
            count := 0;
            FOR i := 0 TO size DO
                flags[i] := TRUE;
            FOR i := 0 TO size DO
                IF flags[i] THEN
                    BEGIN
                        prime := i + i + 3;
                        k := i + prime;
                        WHILE k <= size DO
                            BEGIN
                                flags[k] := FALSE;
                                k := k + prime
                            END;
                        count := count + 1;
                    END;
        END;
    WRITELN(count, ' primes')
END.
```

Table 5 shows the results of the test. For each compiler, source code was read from disk, an object file was produced on disk, and a listing was produced on the screen. I used Alcor's nonoverlaid version of the compiler (the faster one). Pascal-80 took only 8 seconds to compile the benchmark compared to Alcor's 45 seconds. The Alcor compiler is not especially slow—it's just that Pascal-80 is very fast. Alcor said that its compiler is slower than Pascal-80 because it does more work to generate faster-running programs. The results in the rest of the table support this claim.

The benchmark ran 3.5 times faster under Alcor Pascal than under Pascal-80. The Alcor Z80-code generator

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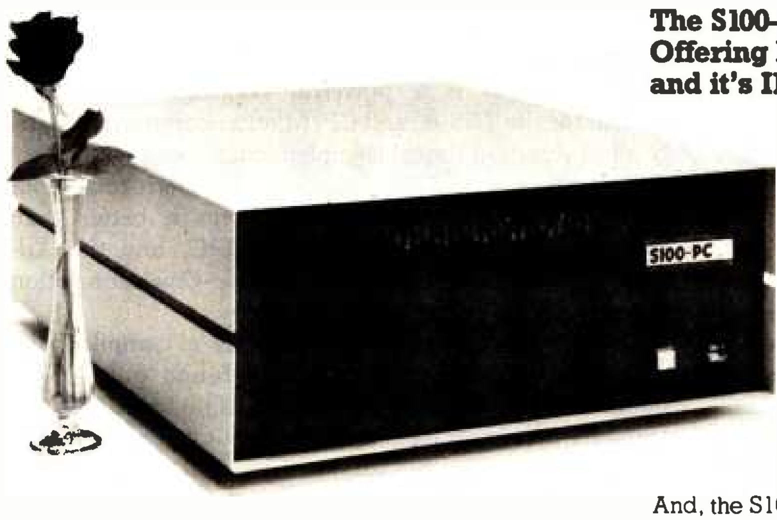

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speeds this up by another factor of 3.5, for a total of 12.25 times faster than Pascal-80. For a reference point, Pascal-80 runs this benchmark about 3.33 times faster than Level II BASIC.

Documentation

Alcor Systems' manual is professional and a pleasure to use. In an industry in which most program documentation is barely adequate, Alcor has done a commendable job. Especially useful is the Quick Reference Guide that covers most aspects of system operation, including editor, compiler, and loader commands, error messages, the ASCII character set, and the Pascal language syntax.

The manual comes in a sturdy three-ring loose-leaf binder. It contains a Beginner's Guide, four main sections, and an index. The first section concisely describes the Blaise text editor. Although some familiarity with file-editing concepts is assumed, all of the editor commands are adequately described.

The second section is devoted to the use of Alcor Pascal with your hardware. Alcor included specifics of operating the compiler and linking loader, along with a description of internal number representation and details of the TRS-80 procedure, function, and string libraries.

A 71-page tutorial section is also included, which takes you through the elements of Pascal programming with lots of sample program fragments. The source code for the examples is included on disk. A tutorial quiz follows some of the chapters. Answers to the quizzes must be found in the text, as separate answer keys are not supplied. The chapter ends with a 9½-page sample database program, also included on disk.

A 103-page reference section follows the tutorial, with detailed descriptions of every aspect of Pascal syntax and semantics. Examples show the use of most keywords but are not always extensively explained. If you are already familiar with Pascal or a similar language, the tutorial and reference sections together are probably all you will need. If your experience is limited to BASIC, you may want to invest in a good Pascal textbook as well.

Conclusions

Alcor Pascal is a powerful language-development system for the TRS-80 and CP/M microcomputers. Nearly all of standard Pascal is implemented along with many useful extensions to the language. The performance of Alcor Pascal programs is usually much better than equivalent programs written in BASIC, and the Advanced Development Package Z80-code-generator option lets you produce even faster programs.

For a new product as complex as a compiler, the system is commendably reliable; I found only a few minor bugs. Alcor has produced a significant piece of software that I can recommend without reservation.■

Rowland Archer (5420 Loyal Place, Durham, NC 27713) is manager of software development for a minicomputer company. He has been working with TRS-80s for four years.

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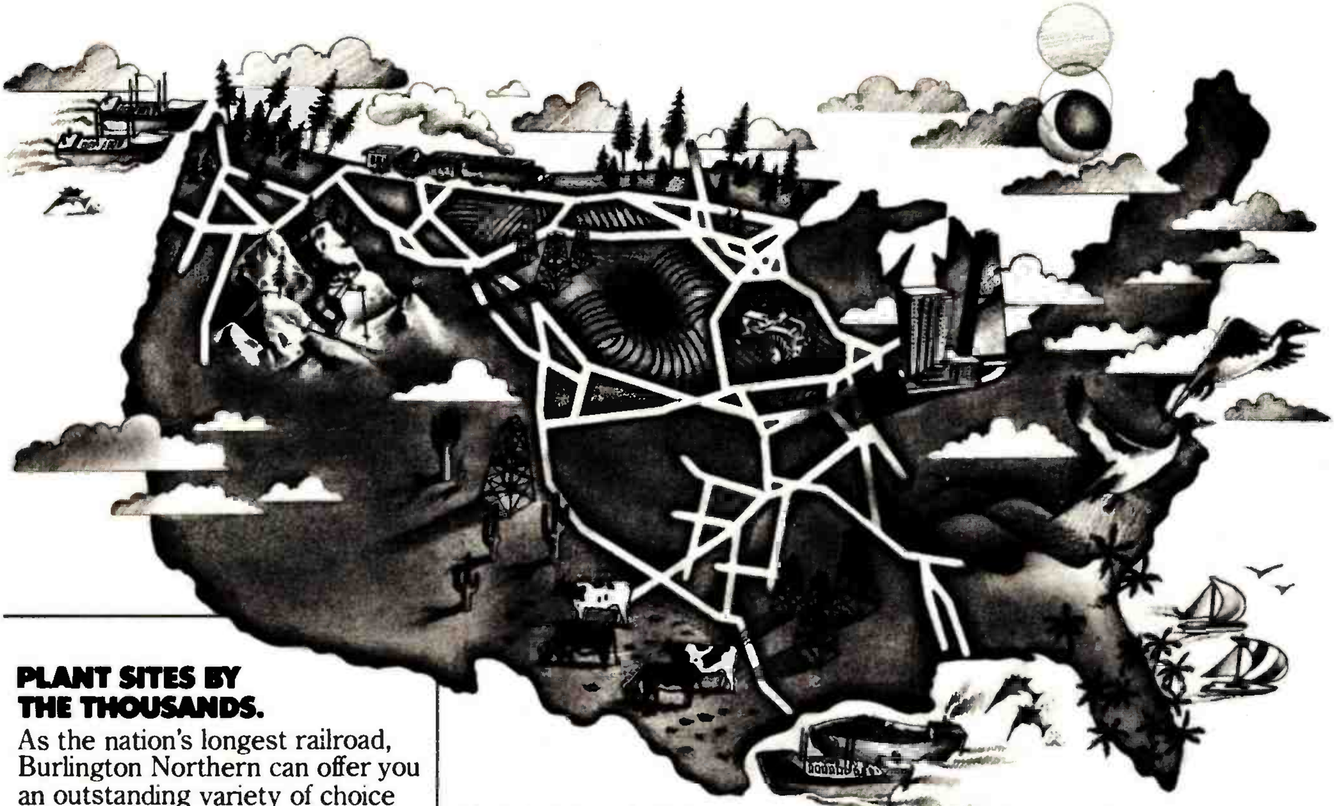

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Add High-Level Logical Structure to Your FORTH Assembler

Some extensions to your FORTH assembler package can make your assembly-language programs more readable and easier to write

by Victor Joseph Grazi

[**Editor's Note:** *Although this article directly applies to FORTH users who already have a FORTH 8080 assembler, I hope that all assembly-language FORTH users will read it. Most of the ideas contained here can be easily transferred to other microprocessors. In addition, the set of FORTH words described at the end of the article removes one of the main objections to using assembly language with FORTH, the inability to mix high-level FORTH words and assembly-language words in the same definition. This supports my view of FORTH, that you can have anything you want in it, but you have to be willing to implement it yourself. . . .*G. W.]

We all know the advantages of assembly-language programming. Unfortunately, we also are intimately aware of its disadvantages. (Mr. Murphy encapsulated the problem quite snugly in his ubiquitous law.) The source of the difficulty is that assembly language lacks the fundamental structures we have come to rely on in the higher-level languages. Included among these structures are variables, variable operators, logical structures, and logical connectives.

The FORTH assembler (being a simple one-pass assembler) compounds the problem by not allowing forward references. It alleviates the tension somewhat, however, by having several logical structuring constructs that, in principle, remove the need for explicit forward references. These structures are

- BEGIN, ... AGAIN,
- BEGIN, ... UNTIL,
- BEGIN, ... WHILE, ... REPEAT,
- IF, ... ELSE, ... THEN,

The purpose of this article is twofold: to extend the list of logical constructs by defining a set of FORTH words that allows the programmer to think in terms of high-level language while programming in assembly language and to explain the method used so that more words can be defined at will by the programmer as needed.

For the benefit of those who have never seen FORTH assembly language, I must add that FORTH assemblers use reverse Polish (postfix) notation (RPN). For example, JMP LABEL in traditional assembly language is tran-

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scribed as { LABEL JMP, } in FORTH assembly language. [*The braces are the BYTE standard notation for isolating FORTH phrases and FORTH words that include punctuation. . . .G. W.*] Where one would load a register by MOV A,B in the traditional version, the FORTH user would write { B A MOV, } (the comma in { MOV, } is part of the word). MVI H 0FFH becomes { FF H MVI, } and PUSH H is now { H PUSH, }. Note the FORTH convention of ending all words that assemble code into the FORTH dictionary with a comma.

One other important implementational difference between traditional assembly language and FORTH structured assembly language is the use of *compound conditional branch notation*, in which the status flag is treated as an operand. For example, RC (return on carry) in traditional assembly language becomes { CY RETC, } (carry, return on condition) in FORTH; JNZ LABEL in assembly language becomes { LABEL < >0 JMPC, } (not zero, jump on condition to LABEL).

The status-flag operands are

- < >0 (not zero)
- =0 (zero)
- NC (not carry)
- CY (carry)
- PO (parity odd)
- PE (parity even)
- > =0 (positive)
- <0 (negative)

The test and branch words are

- CALLC, (call on condition)
- RETC, (return on condition)
- JMPC, (jump on condition)

as well as the standard structure words listed at the beginning of the article. You are now initiated.

Let us examine the { BEGIN, ... WHILE, ... REPEAT, } construct. This construct assembles the appropriate jumps so that, when executed, the code that occurs between { BEGIN, } and { WHILE, } is executed. If the test condition is true at that point, the code between { WHILE, } and { REPEAT, } is executed. This is followed by another round starting back at { BEGIN, }. The cycle continues until the { WHILE, } condition becomes false.

But format does not make the intended meaning as obvious as possible. For example:

```
         BEGIN,
                   B ORA,
    < >0 WHILE,
                   M B MOV,
                   H INX,
         REPEAT,
```

becomes somewhat clearer with a little grooming:

```
WHILE( B ORA, < >0 )W
         M B MOV,
         H INX,
REPEAT,
```

and the difference is even more dramatic when variables are introduced.

In this trivial case, the words { WHILE(} and {)W } are simply pseudonyms for { BEGIN, } and { WHILE, } respectively:

```
: WHILE(   BEGIN, ;
: )W     WHILE, ;
```

Variables

A variable is a 16-bit location in memory with a label initially assigned by the FORTH word VARIABLE . For example, { 0 VARIABLE TEST-VAR } creates a variable named TEST-VAR and assigns it an initial value of 0. The phrase { TEST-VAR LHLD, } picks up the value of TEST-VAR and loads it into the HL register pair. And { TEST-VAR SHLD, } assigns the value in the HL register pair to the variable named TEST-VAR . Suppose we have two variables named P and Q . To assign the value of Q to P we could write { Q LHLD, P SHLD, }. [*Remember that P and Q are addresses, the values of which are placed on the stack and used by { LHLD, } and { SHLD, }. . . .G. W.*] This is short, but it is not as elegant as { P Q < — }, where the word < — is defined by

```
: <—   LHLD, SHLD, ;
```

Immediate assignment is similar. To assign the variable P the value 3, we could write { 3 H LXI, P SHLD, }, but { P 3 < —# } has obvious advantages where the new word < —# is defined by

```
: <—#   H LXI, SHLD, ;
```

To increment the variable P by 1, we are no longer bound by { P LHLD, H INX, P SHLD, }, for we can now do the same thing with { P + + }, where + + is defined as

```
: ++   DUP LHLD, H INX, SHLD, ;
```

Similarly:

```
: --   DUP LHLD, H DCX, SHLD, ;
```

Keep in mind that these words do not assemble any obscure code; they are merely handy macro abbreviations for the desired assembly-language code.

For comparison of variables, a subroutine called { (COMPARE) } is in order (its definition is given in listing 1). Now we can define

```
: COMPARE   LHLD, XCHG, LHLD, (COMPARE)
CALL, ;
```

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Listing 1: *A FORTH 8080 assembly-language word called { (COMPARE) }. This word is used to create the word COMPARE ; see the text for details.*

```
    LABEL (COMPARE)  ( compare HL and  DE.  Leave  CARRY flag and zero
flag appropriately set by the result.  Don't modify HL or DE.  )
          B PUSH, A B MOV, B PUSH, ( save BC and A )
          H A MOV, D CMP, ( compare high bytes )
            =0 IF, ( if equal, compare low bytes )
                   L A MOV, E CMP,
               THEN,
          B POP, B A MOV, B POP, ( restore BC and A, don't touch flags)
    RET,
```

Listing 2: *The FORTH definitions of the words { RETURN(} and {)R }, which allow an assembly-language definition to return to FORTH, depositing set variables onto the stack. See the text for details.*

```
: RETURN( CSP @ !CSP ;
: )R SP@ >R CSP @ R> - -DUP ( get stack depth )
    IF
         2 =
              IF ( if 2 bytes, i.e.  one single precision number)
                   LHLD, HPUSH ( assemble HPUSH )
              ELSE ( otherwise, assemble DPUSH )
                   LHLD, XCHG, LHLD, XCHG, DPUSH
              THEN
    ELSE ( no parameters )
              NEXT ( assemble jump to NEXT )
    THEN
    CSP ! ; ( reset CSP )
```

so that the code to compare P and Q can be assembled by { P Q COMPARE }, leaving the status flags appropriately affected by the result of P − Q. (The value of P remains in HL and the value of Q remains in DE.)

To assemble an exit back to FORTH from the word being defined, we would normally end the assembly-language definition with NEXT to exit with no output parameters, HPUSH to exit with the value of the HL register pair returned on the stack, or DPUSH to exit with the value of the HL register pair returned on the top of the stack and the value of the DE register pair returned beneath it. [*These words evidently compile JMPs to routines named NEXT, HPUSH, and DPUSH, all of which are special entry points to the FORTH interpreter. . . .***G. W.**] The two FORTH words { RETURN(} and {)R } simplify this arrangement. The phrase { RETURN(P)R } assembles a return to FORTH with the value of the variable P left on top of the stack, and the phrase { RETURN(P Q)R } assembles the exit with the value of Q on top of the stack and the value of P beneath it. Note that P and Q *must* be variables and, as such, must point to their respective values. For example, to return with 2 and 1 on the stack, the desirable { RETURN(2 1)R } will fail. You could use

```
2 VARIABLE TWO
1 VARIABLE ONE
RETURN( TWO ONE )R
```

to accomplish the desired result. The phrase { RETURN( )R } with no output parameters is a pseudonym for NEXT .

The definition of the { RETURN(...)R } construct, shown in listing 2, is the most complex. Note that { IF ... ELSE ... THEN } is the high-level FORTH counterpart of the { IF, ... ELSE, ... THEN, } assembly-language construct. Its usage is proper in the definition of this macro rather than the assembly-language

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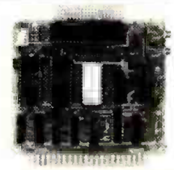

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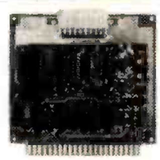

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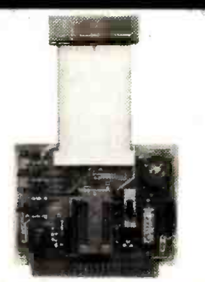

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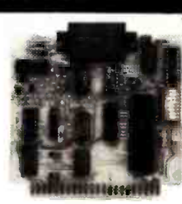

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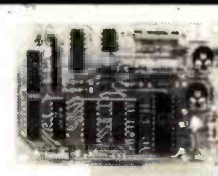

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form because the decision to be made is which code to assemble during assembly time as opposed to which branch to take during run time.

While we're on the subject of variables, let's see how we might access the members of a one-dimensional character array residing in memory. Normally, if STRADDR were the location of the first element of the array and we wanted the Nth item in the array (both STRADDR and N are variables), we would write

```
N LHLD, XCHG, STRADDR LHLD, D DAD,
```

which would leave the HL register pair pointing to the desired element. But we can define a word that will assemble all the messy stuff for us:

```
: []   LHLD, XCHG, LHLD, D DAD, ;
```

Now, if we want to get the Nth element of STRADDR into the A register, for example, we would write

```
STRADDR N [] M A MOV,
```

Other niceties include the following definitions:

```
: <    COMPARE <0 ;
: =    COMPARE =0 ;
: >=   COMPARE >=0 ;
```

These definitions allow us to write

```
P Q < RETC, ( return if P less than Q)
```

or

```
P Q = IF, H INX, THEN, ( if P = Q, then
increment HL)
```

Other variations include <# , which compares a variable on the left with an immediate number on the right. The definition

```
: <#   LXI, XCHG, LHLD, (COMPARE)
CALL, <0 ;
```

allows us to do the following:

```
P 0 <# RETC, ( return if value of P is negative).
```

A significant source of frustration in assembly language, particularly FORTH assembly language, is the lack of a convenient way to branch based on the results of two or more independent tests. For example, in any high-level structured language, you can write something such as

```
WHILE (P = Q AND N < 3 )
...
REPEAT
```

Listing 3: *These FORTH words allow compound logical tests to be carried out in assembly-language definitions. See the text for details.*

```
: LOGICAL STC, IF, CMC, THEN, CMC, PSW PUSH. , ( set or reset
CARRY flag based on truth of condition, push PSW )
: L... XTHL, XCHG, ( PSW in DE, HL to stack )
      LOGICAL ( set CARRY, push PSW )
      XTHL, ( PSW in HL, DE to stack )
      L A MOV, ; ( get flags into A )
: ...L A L MOV, H PUSH, PSW POP, ( new flags and A into PSW )
      D POP, H POP, ( restore registers )
      CY ( ready for test of CARRY flag ) ; ( end of macro )
: AND, L... E ANA, ( perform AND, on CARRY flags ) ...L ;
: OR, L... E ORA, ( perform OR, on CARRY flags ) ...L ;
: XOR, L... E XRA, ( perform XOR, on CARRY flags ) ...L ;
```

A convenient facsimile for our structured assembler would be used as follows:

WHILE(P Q = LOGICAL N 3 <# AND,)W
...
REPEAT

The word LOGICAL assembles code that sets or resets the carry flag based on the truth of the condition (in this case, equality). Then it saves the program status word on the stack until a connective word ({ AND, }, { OR, }, or { XOR, }) is reached. The connective word then assembles code that sets or resets the carry flag based on the truth of the condition (in this case, <#) and performs the appropriate *and*, *or*, or *exclusive-or* operation on the current carry flag with the value of the carry flag as it was at the time it was saved by LOGICAL. Effectively, the LOGICAL construct applies the appropriate logical connective word ({ AND, }, { OR, }, or { XOR, }) to the expression up to the word LOGICAL, with the expression between LOGICAL and the connective. LOGICAL, { AND, }, { OR, }, and { XOR, } are defined so that they do not modify any of the machine registers; see listing 3.

Mixing High- and Low-Level Words in FORTH

If you have made it this far, I have a special surprise for you. I will now define a word that will allow you to mix high-level FORTH words with low-level assembly-language words, back and forth as often as you like, right in the same word definition. The word ASM< is actually an in-line assembler that is used as follows:

: ASM-TEST ... (FORTH words) ... ASM< ...
(assembly-language words) ... FORTH<
... (FORTH words) ... (etc.) ... ;

The definitions of ASM< and FORTH< are given in listing 4. The word ASM< saves the current base and CONTEXT vocabulary. It also compiles a mock CFA (code-field address) pointer, which appears to the interpreter as

Listing 4: *The FORTH definitions of the words ASM< and FORTH< , which allow you to mix high-level and assembly-language words in the same definition. See the text for details.*

```
: ASM< BASE @ CONTEXT @ @ ( save base and CONTEXT vocabulary on
stack )
      HERE 6 + , ( compile mock CFA pointer )
      COMPILE BRANCH HERE 0 , ( compile branch around code, offset
to be filled in by FORTH< )
      HERE 2+ , ( compile mock CFA )
      [COMPILE] ASSEMBLER ( set ASSEMBLER vocabulary )
      [COMPILE] [ ; ( enter execution mode for assembly )
       IMMEDIATE ( to be executed in compile mode )
: FORTH< HERE OVER - SWAP ! ( fill in offset of branch )
      NEXT ( assemble jump to next )
      CONTEXT @ ! BASE ! ( restore vocabulary and base; reset
compile mode )
      ] ; ( resume compilation mode )
```

a standard FORTH CFA pointer as compiled into a standard FORTH word. This pointer indicates the address where the code is to be assembled. It then compiles a FORTH branch around the code, so that when the code is done executing, control passes back to FORTH beginning with the word following the assembled code (see figure 1).

The word FORTH< assembles a jump to the FORTH

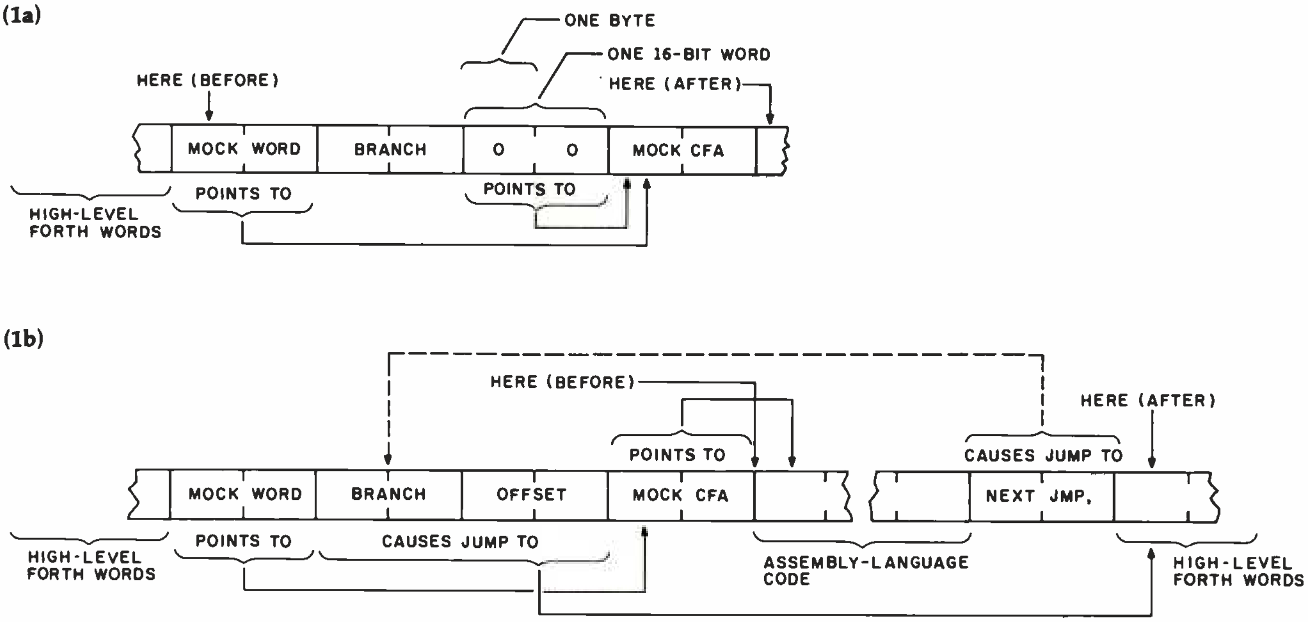

Figure 1: *Operation of the FORTH words ASM< and FORTH< . In 1a and 1b, the condition of the dictionary is shown after the words ASM< and FORTH< , respectively, have executed. The words HERE (BEFORE) and HERE (AFTER) show the positions of the dictionary pointer before and after the given word has executed. See listing 4 and the text for details.*

Listing 5: *An 8080 assembly-language definition that uses some of the words defined in this article. The word MATCH does a substring search as defined in the text.*

```
0 VARIABLE I
0 VARIABLE J
0 VARIABLE K
0 VARIABLE FALSE
1 VARIABLE TRUE
CODE MATCH  ( TXTAD, CNT, STRAD, LEN --- flag, offset )
H POP, LEN    SHLD,
H POP, STRAD  SHLD,
H POP, CNT    SHLD,
H POP, TXTAD  SHLD,
I 0 <-#
    WHILE( I CNT < )W
        J I <-  K 0 <-#
            WHILE( K LEN <  LOGICAL TXTAD J []  M A MOV,
                     STRAD K []  M CMP, =0 AND, )W
                J ++  K ++
            REPEAT,
        LEN K =
            IF,
                RETURN( TRUE I )R
            THEN,
        I ++
    REPEAT,
RETURN( FALSE I )R
```

inner interpreter routine NEXT and restores the base and vocabulary as it was before ASM< . Note that all this occurs during compilation time. At run time, the code appears to be a standard FORTH word, with all the jumps and branches already having been assembled and compiled during compile time.

None of the machine registers are preserved across FORTH words except for the BC register pair, which contains the FORTH interpretive pointer (which is similar to the machine's program counter) and must always be preserved.

The scope of these methods is endless. Using them, you can define arithmetic operators, 1-byte compare operators, DO loops, FOR ... NEXT loops, or any structures you want from your favorite languages.

I will conclude with an example. Suppose you want to code a program that is to search CNT bytes of text beginning at TXTAD for occurrences of the string of length LEN at STRAD , where TXTAD , CNT , STRAD , and LEN are variables. The program in listing 5 will load the initial values from the stack as indicated and then perform the search. The number of bytes searched will be returned on top of the stack and a true flag beneath it if the string was found, or a false flag otherwise.

The listing 5 program is strictly FORTH-structured 8080 assembly language. Any similarity to popular high-level languages is purely intentional. ■

About the Author

Victor Joseph Grazi, who has a master's degree in math, can be reached at 220 Elberon Blvd., Oakhurst, NJ 07755. He is offering copies of his implementation of fig-FORTH, available for $50 on North Star double-density CP/M disks, with the source and users manual included.

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Clubs and Newsletters

C Software for Unix

Infopro Systems specializes in new software and hardware products that run Unix or Unix-like operating systems and programs written in the C language. The monthly newsletter, *The Unix Software List*, includes product reviews, tutorials, industry analyses, and details about where to find the latest products. Subscriptions are $54 a year and $66 overseas; educational and bulk discounts are available. For information, contact Susan Fiedler, Infopro Systems, POB 33, East Hanover, NJ 07936, or call (201) 625-2925.

Osborne Group in British Columbia

The Vancouver Island Osborne Group (VIOG) meets on the third Thursday of every month at the Saanich Public Library, Victoria, British Columbia. Communication with other user groups is welcome. A one-time registration fee of $20 entitles you to receive the newsletter, *VIOG News*. For further information, contact Jack Walraven, Vancouver Island Osborne Group, 2840 Leigh Rd., Victoria, British Columbia V9B 4G3, Canada, or call (604) 474-1750 weekends or after 7 p.m.

For Sirius Users

Channel 9000 is an independent, bimonthly newsletter produced by the Percentage Corporation for technical users of the Victor 9000/Sirius 1 computers. It features tutorials, news, and information. Subscriptions are $30 a year. For a complimentary copy, write to *Channel 9000*, 9742 Marcus Lane, Tujunga, CA 91042, or call (213) 352-6443; Compuserve: 72205,43.

Start with ZSTART

ZSTART is the monthly newsletter produced by the Z80 Starter Kit User Group. All owners of the SD Systems Z80 Starter Kit are welcome to join. Annual newsletter subscriptions are $10 in North America and $15 elsewhere. For information, contact the Z80 Starter Kit User Group, 6000 Puffer Rd., Downers Grove, IL 60516.

For Doctors and Dentists

The Windham Newsletter, produced bimonthly by Windham Software Inc., contains articles on medical and dental office-management software that runs on IBM and Tandy microcomputers. Annual subscriptions are $15. For further information, contact Windham Software Inc., 29/31 Ivanhill St., Willimantic, CT 06226, or call (203) 456-3530.

Interact's Tenth

The HP 3000 International Users Group is an independent, nonprofit association of those who use timesharing systems. Currently in its tenth year, the association produces a bimonthly publication, *Interact*, as well as a quarterly technical journal. Annually, the group issues a tape of user-contributed software and sponsors two conferences, one in North America and the other in Europe. For information, write to HP 3000 International Users Group Inc., Suite 205, 289 South San Antonio Rd., Los Altos, CA 94022, or call (415) 941-9960.

BAUG's BAUD

Big Apple Users Digest (BAUD) is the monthly publication of the Big Apple Users Group (BAUG) in New York City. The club consists of various committees and special-interest groups. The $30 membership fee includes a subscription to *BAUD*. Single issues are $2 a copy; newsletter exchanges are welcome. For further information, write to BAUG, POB 490, Bowling Green Station, New York, NY 10274.

Meet in Oregon

The Portland Area TRS-80 Users Group (PAUG) meets twice a month and produces a monthly newsletter. For further information, contact PAUG, POB 02500, Portland, OR 97202, or call (800) 452-2444 days and (503) 659-4088 evenings.

Attention: Neuroscientists

The Neurocybernetics Research Group (NRG) is dedicated to advancing the uses of microcomputers in real-time analysis and feedback of EEG signals that create video representations of human thought patterns. The NRG produces a periodic newsletter that contains reviews on scientific research in brain simulation and summaries of members' computer-related activities in nonclinical brain research. Individual dues are $95 a year; institutional and corporate fees are $250 a year. For further information, write to the Neurocybernetics Research Institute, POB 1678, Costa Mesa, CA 92626, or call (714) 662-7739.

Many Benefits from JACG

The Jersey Atari Computer Group (JACG) is an independent organization of Atari users that meets on the second Saturday of each month at 10 a.m. in the Bell Labs Auditorium, Murray Hill, New Jersey. A $15 annual membership fee includes a subscription to the monthly newsletter, access to a disk library, and discounts on group software purchases. For more details, write to JACG, 58 Dewey Ave., High Bridge, NJ 08829.

ZBUG for Businesses

ZBUG is an independent group for people using Zenith microcomputers in business. It strives to increase your productivity and profits through the exchange of information. For further details, write to Gerald Kalish, Suite 2350, 230 North Michigan Ave., Chicago, IL 60601, or call (312) 372-2150.

Australian Club Open to All

The Newcastle Microcomputer Club meets twice a month at the University of Newcastle and is open to anyone interested in furthering computer education. The

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Clubs and Newsletters

$5 annual fee includes a subscription to the monthly newsletter. For more information, contact the Newcastle Microcomputer Club, POB 293, Hamilton, New South Wales 2303, Australia.

NOHUG News of New Orleans

The New Orleans Heath Users Group (NOHUG) produces a newsletter, *NOHUG News*, that contains reviews, updates, and tips. Meetings are held regularly. The group has a bulletin-board service: (504) 467-9896. For further information, write to *NOHUG News*, Heathkit Electronics Center, 1900 Veterans Blvd., Kenner, LA 70062.

IBM at Home and at Work

The North Texas IBM Personal Computer Users Group meets regularly to discuss the uses of IBM Personal Computers at home and work. The group produces a monthly newsletter, the *North Texas PC News*, that includes columns, reviews, updates, and an exchange column. For further details, contact J.P. Pribyl, North Texas IBM Personal Computer Users Group, 2025 Rockcreek Dr., Arlington, TX 76010, or call (817) 275-4109.

Green Mountain Apple Languages

Kingdom Computer Concepts' Newsletter, produced bimonthly by Kingdom Computer Concepts, contains news, programming techniques, and listings written in Apple Pascal and assembly language. Request a free introductory issue from C. Sjolander, Kingdom Computer Concepts, POB 182, St. Johnsbury Center, VT 05863.

New Zealand Enthusiasts Meet

Micro, the monthly publication of the New Zealand Microcomputer Club, provides an events diary and reports on the activities of more than ten special-interest groups. The group meets on the first Wednesday of each month in Auckland. A lending library of computer magazines and books is maintained. The $12 annual membership ($6 for students) includes a subscription to *Micro*. Address further inquiries to the secretary, New Zealand Microcomputer Club Inc., POB 6210, Auckland, New Zealand.

London Computer Clubs Association

The Association of London Computer Clubs (ALCC) coordinates the diverse plans of 15 computer clubs in London, England. To promote recreational and hobby computing in London, it organizes seminars, provides discounts, and exchanges newsletters. Individual club meetings are open to all those affiliated with ALCC. Recent meetings have consisted of lectures and demonstrations on the BBC microcomputer, graphics, and telesoftware. For further information, write to the Association of London Computer Clubs, North London Hobby Computer Club, The Polytechnic of North London, Holloway, London N7 8DB, England, or call 01-607 2789; Telex 25228. ■

Conducted by Steve Ciarcia

Getting a Handle on Disk Removal

Dear Steve,

My new IBM Personal Computer was just delivered and I have a problem with the disk drives: there are no ejectors, which makes removal of a disk a delicate operation. It is a special problem for me because I am disabled and my manual dexterity is poor.

Do you have any suggestions for disk removal? Perhaps a tool of suitable material is what's needed, but so far I've had no luck finding such an instrument.

Bob Hayes
Dallas, TX

The IBM's 5¼-inch disk drives do not include an ejector mechanism to facilitate disk removal. Because the door on the disk drive only covers the center position of the disk, it would be possible to tape a handle to each disk. This could be a string or a semicircular piece of thin plastic that would extend or hang out of the drive when the disk is inserted. Removal would be simplified because your capture range would be significantly increased. I am not aware of any tool designed for such a purpose, but there are some disk drives that have a full-width door (e. g., Siemens makes one). . . .**Steve**

Signal Conversions

Dear Steve,

For several years I have been using Michael Shrayer's Electric Pencil with my North Star computer for word processing in my law practice. As you probably know, that program does not work with conventional terminals. I am using a Polymorphic VTI video board with an RF (radio frequency) interface and an old television set; the resolution of that setup leaves something to be desired.

I have put together a Heath H-19A terminal for my other programs and with the hope of modifying it to act as a video monitor as well as a terminal. Alas, the Heath terminal video section does not use the composite-video signal of the sort generated by the Polymorphic board; it uses separate horizontal and video synchronization signals. Perhaps I can pick off those signals on the Polymorphic board, but I would prefer to modify the Heath terminal with a gizmo that converts the composite-video signal to that accepted by the Heath video section, with a switch to go from the terminal mode to the monitor mode. Do you know of such a unit?

Michael Downey Rice
Port Washington, NY

The gizmo that you require is called a sync separator. Its function is to pick off the horizontal and vertical synchronizing pulses contained in the composite-video signal and provide separate outputs. A suitable circuit appeared in the January 6, 1982 issue of EDN magazine on page 207. . . . **Steve**

Capacitors Improve Response, Prevent Oscillation

Dear Steve,

In trying to build a new power supply for a pair of 8-inch Shugart floppy-disk drives, I somehow came up with the schematic in figure 1 for a 24-V (volt) regulator. After building the supply, I found a problem in the 24-V portion. It provides a steady 24 V DC as long as there is a load across it (the head-load solenoid in this case). When the head unloads, the output voltage starts to oscillate between 7 and 37 V. It continues to oscillate until the AC power to the supply is switched off and on, at which time the voltage goes back to 24 V until the supply is loaded then *unloaded* again. What is causing this problem? Any suggestions will be appreciated.

Thank you.

Mike Minter
Denton, TX

It's a good design practice to place small-value capacitors on the input and output of three-terminal regulators to improve transient response and prevent oscillation. The input capacitor C_i can be anything from about 0.33 to 1.0 μF (microfarad). Tantalum capacitors are recommended for their high-frequency bypass characteristics, but disk ceramics will suffice. The output capacitor C_o should be from 0.01 to 0.20 μF and disk ceramic is acceptable. The actual values are not critical, but they should not be omitted. . . . **Steve**

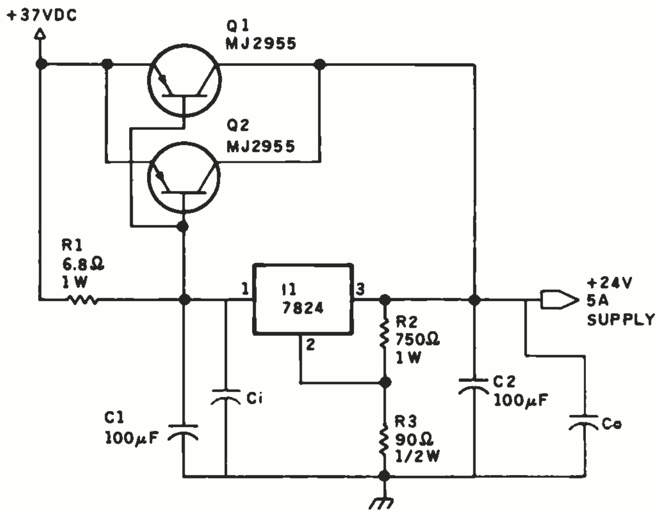
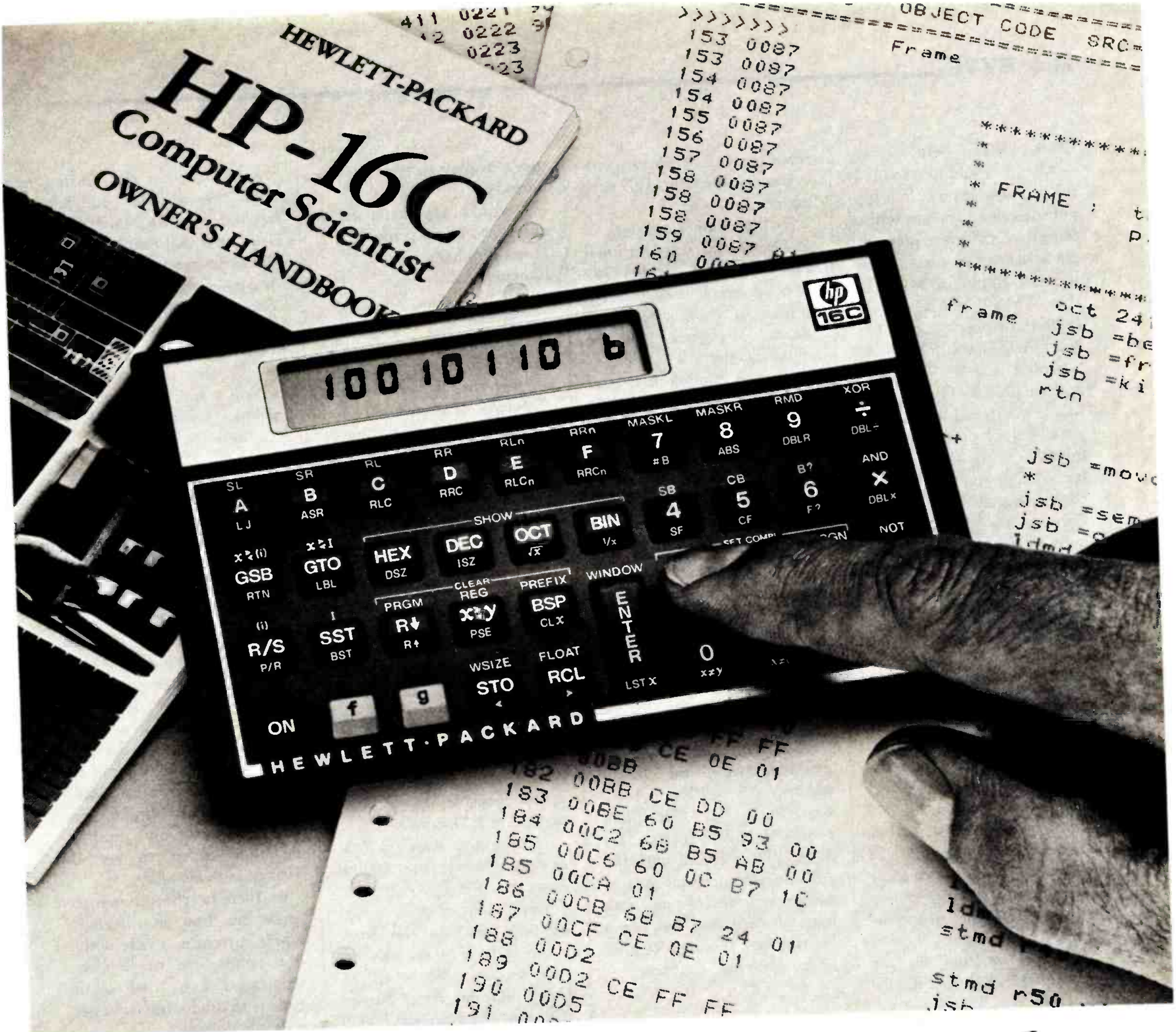


Figure 1: *Output current of a three-terminal voltage regulator can be increased by using two transistors in parallel. Don't forget to include capacitors, to prevent oscillation.*

Conversions and Interfaces

Dear Steve,

I would like to build a data-acquisition system for use in a biomedical research laboratory. The system must be able to sample and store 1000 samples for each of two analog signals, have 8-bit accuracy, and be able to sample at rates from 1 kHz to 1 MHz. Is the Z8-based computer described in BYTE fast enough to handle these sampling rates? (See "Build a Z8-Based Control Computer with BASIC," Part 1, July 1981 BYTE, page 38; Part 2, August 1981 BYTE, page 50.) Could you suggest an A/D (analog-to-digital) converter that can handle these sampling rates? The voltages sampled would range be-



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tween +5 and −5V.

Also, I would like to build the color-graphics interface you described for use with a Sinclair ZX81 computer, but am unsure as to what control signals I should use to control the TMS9918ANL VDP (video display processor). (See "High-Resolution Sprite-Oriented Color Graphics," August 1982 BYTE, page 57.) I have interfaced my ZX81 to parallel I/O ports, so I am familiar with simple interfacing. Can you tell me which control signals I should use? Can you also give me the approximate price of the TMS9918ANL VDP and a source for this chip?

Dr. Bill Jackson
Charlottesville, VA

Because the Z8 BASIC computer runs a BASIC interpreter, its execution of instructions is slower than the 7-MHz clock rate might imply. The system actually executes much less than 100,000 average BASIC instructions per second, so this would not meet the upper limit of your requirements. The problem here is that the processor must execute tens of machine-level instructions for each interpreted BASIC instruction.

In fact, it would take a pretty fast microcomputer to take 8-bit samples at a 1-MHz rate, especially if the system must save them in mass storage (floppy disk) at the same time. Even if the software to process the samples was written in machine code, there would only be enough time for the system to save them in memory. Because 8-bit microprocessors can only address a maximum of 64K-byte memory locations, you would be limited to less than 66 ms (milliseconds) of recording time at a 1-MHz rate. The only solution is to reduce the sampling rate or resort to some method of direct memory access for your A/D converter.

If you can live with a 10-kHz sample rate, National Semiconductor's MM5357 A/D converter is easy to interface to 8-bit microcomputers. I suggest you see James Cameron's "A High-Resolution Analog-to-Digital Converter" (February 1983 BYTE, page 378). His article contains information on the MM5357, as well as a schematic diagram showing how to interface it to a Radio Shack TRS-80.

The control signals necessary for the E-Z Color board are the R/W line, a Device-Select line, Reset, one address line, and eight data lines. All of these signals can be obtained from the expansion connector on the rear of the Sinclair ZX81.

*The TMS9918ANL VDP is available from the Micro Mint (561 Willow Ave., Cedarhurst, NY 11516, (800) 645-3479; in New York, (516) 374-6793). It comes with the 10.7386-MHz crystal and a comprehensive 114-page data manual published by Texas Instruments. It costs $50, plus $2 for shipping. . . .***Steve**

CP/M Offers Machine Independence

Dear Steve,

I would like to know of any books or articles that deal with making a program machine-independent. I am particularly interested in programming Intel's 8080 and Zilog's Z80 microprocessors. Specifically, I would like to know how to query a disk drive to determine record size, number of records per side, single- or double-density, and single- or double-sided. Are there any short cuts to finding which port the video-display console is connected to?

I would appreciate references you could provide.

James Bingham
Phoenix, AZ

The fact that there are so many computers on the market with incompatible software testifies to the lack of machine-independent programs. Even if the programs were written for one processor, there is no standard for I/O locations.

The CP/M operating system is designed for 8080 and Z80 microprocessors and has been adapted for many computers. Programs written under CP/M are essentially machine-independent because a program written on one system can be run on another. CP/M has commands that let you query a disk drive for file status and record size and to send data to the console, the printer, and other I/O devices.

Information about CP/M can be obtained from Digital Research (POB 579, Pacific Grove, CA 93950, (408) 649-3896) or from the many books written on the subject, such as the Osborne CP/M User Guide *by Thom Hogan (Osborne/McGraw-Hill, 630 Bancroft Way, Berkeley, CA 94710). . . .* **Steve**

Phony Specs

Dear Steve,

I heard that a major semiconductor manufacturer once put out a specification sheet for a "write-only" memory. Apparently the company got orders for it and sent out a rather caustic letter to those who had been taken in.

Do you have any knowledge of this? I'd like to hear about it—I'd also like a copy of the specs!

Joe Pollack
Buffalo, NY

I came across the "write-only" memory that you referred to in the April 1977 issue of Kilobaud *(now* Microcomputing*) in an article by Peter A. Stark entitled "Everything about Semiconductor Memory." The specification sheet was published by Signetics and was obviously a spoof on a typical memory specification sheet. . . .* **Steve**

Remote Control Feedback

Dear Steve,

I'm gradually converting many of my home's lights and appliances to remote control via the BSR/10X systems. I have a problem getting feedback to determine whether a motor is actually running or a light is actually on or off. One night I had an outside light (on a wall-switch control) blinking on and off randomly until a neighbor called to see if everything was okay.

Is there a cheap way to sense the flow of a 1-amp, 60-Hz current in a wire without connecting to it electronically? I've tried small coils with diodes but can't get a usable voltage.

R. S. Peterson
Nashville, TN

The problem of monitoring computer-controlled devices is formidable. A simple way is to insert a 1- to 2-ohm resistor in the line feeding the controlled device and measure the voltage drop. When current is flowing, the AC voltage can be rectified to DC and used as a status signal. An optoisolator is highly recommended in such an application.

Because you don't want an electrical connection to monitor the status, an inductive pick-up coil will give the *necessary information. The output voltage from a coil around the current-carrying wire will be very small and must be fed to a high-gain amplifier to obtain a usable signal. You mentioned that you tried small coils with diodes, but did you include the amplifier?*

Another approach is to have a sensing device, such as a photodiode, at the controlled end to provide a feedback signal. This may require additional wires to carry the sensing signal or the use of another receiver-transmitter pair that operates through the power lines (on different frequencies, of course). . . . **Steve**

Follow-up Information

Dear Steve,

I certainly enjoyed your article "Make Liquid-Crystal Displays Work for You" (October 1980 BYTE, page 24). It's unfortunate that you could not adapt one of the matrix-type devices for a microcomputer peripheral.

Thank you for the information you supplied in reply to my previous letter ("Liquid-Crystal Displays," August 1980 BYTE, page 234). I wrote Texas Instruments for information on the 28-pin, 4-bit TMS1000-series microprocessor that you identified for me. In return, I received a

Serial-to-Parallel Output Conversion

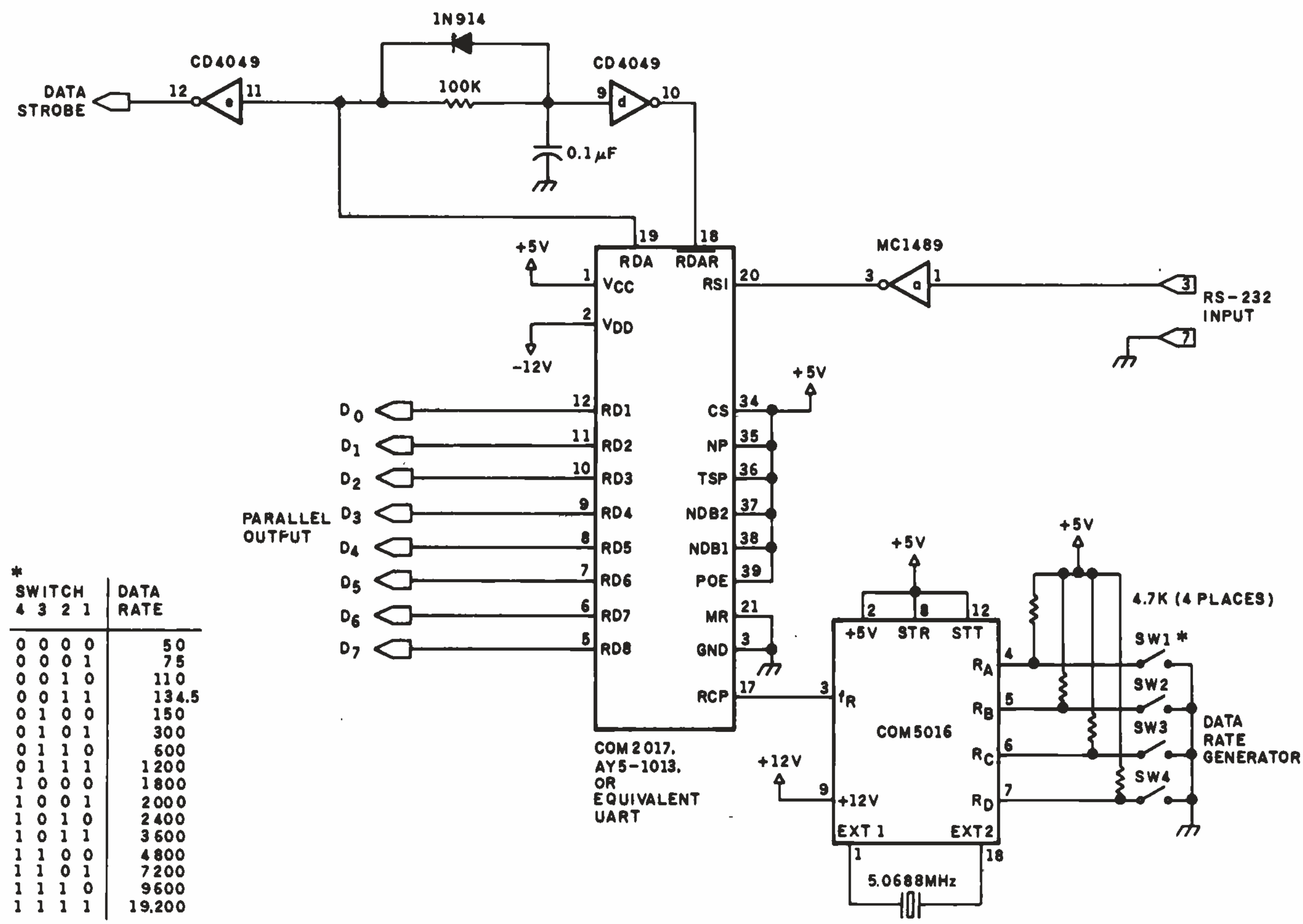
Dear Steve,

About two weeks before your article "Add Programmable Sound Effects to Your Computer" came out (July 1982 BYTE, page 60), I bought an I/O board. I was elated that I could finally interface your projects with my Apple II Plus. I then bought BYTE and there glaring out at me was "A sound synthesizer that can be interfaced with any computer . . . with a parallel interface." Oh well.

Can this project be converted for use with serial I/O?

Scott Seller
Bronx, NY

The easiest method of driving the programmable sound generator described in that article is to use a parallel port such as a Centronics port or equivalent. Lacking such a parallel port, the next easiest method is to convert the serial output to parallel by means of a UART (universal asychronous receiver/transmitter). A suitable circuit is shown in figure 2. . . . **Steve**



* SWITCH 4 3 2 1	DATA RATE
0 0 0 0	50
0 0 0 1	75
0 0 1 0	110
0 0 1 1	134.5
0 1 0 0	150
0 1 0 1	300
0 1 1 0	600
0 1 1 1	1200
1 0 0 0	1800
1 0 0 1	2000
1 0 1 0	2400
1 0 1 1	3600
1 1 0 0	4800
1 1 0 1	7200
1 1 1 0	9600
1 1 1 1	19,200

Figure 2: *This UART circuit converts serial data for use by parallel devices.*

TMS1000 CMOS Family Data Manual. The unit has four input lines, eight parallel-latched output lines, ten separately latched output lines, two clock connections, one initialize, one halt, and two power connections. I cannot, however, find a means of reading out the 1K-byte by 8-bit instruction ROM (read-only memory). When you mentioned disassembling the game program, were you referring to the Intel/NEC 8048 chip in your Mego Mini-Vid, or do you know some secret of the TMS1000 series?

I detected some differences between the custom-display driver circuits in the two games. The Microvision unit has 6 pins connected to the microprocessor and 32 connected to the matrix display, as compared to the 4 and 32 division you reported for Mini-Vid. Perhaps the different display qualities are not entirely due to signal timing. Could you please tell me the name and address of the display-driver manufacturer?

Finally, your description of the inexpensive University Kits prompted me to write Motorola for information on 6800 microprocessor kits. (See "Quick and Cheap," December 1980 BYTE, page 320.) I hope that the company is feeling generous, because these are the first microcomputers that are in my price range.

Daniel Q. Dye Jr.
Denver, CO

The internal program in the Intel 8048 can be read by external interrogation. At one time, NEC (Nippon Electric Company) invited you to send it your Intel 8048 and in exchange you would receive an NEC 8048 with your original program blown onto the new device.

An LCD matrix is expensive. One manufacturer of them is UCE, 24G Fitch St., Norwalk, CT 06855. For the experimenter, buying one of the games and disassembling it for the display is much less expensive than buying a single LCD directly from a manufacturer. The 40-pin driver circuit for the matrix displays is either the HLDC0540 or the HLCD0548 made by Hughes Aircraft. It is available in single-piece quantities for under $6. For specification sheets and a list of distributors, write to Hughes Aircraft Co., Solid State Products, 500 Superior Ave., Newport Beach, CA 92663.

*I'm glad that you are trying to take advantage of the university kits. I am not sure how Motorola approaches this matter, but Intel has always been very attentive to students and colleges. In fact, in response to all the reader queries as a result of my December 1980 note, Intel has expanded the program and is trying to include some of the 8088 devices in it as well. . . .***Steve**

Placing Capacitors Correctly

Dear Steve,

In Micromint's Z8 microcomputer, various capacitors are placed throughout the circuitry. I understand that capacitors are used to smooth the voltage in a circuit, but exactly what rules are used to determine their placement?

John Buckley
Bronxville, NY

Transistor-transistor logic (TTL) devices generate a lot of noise due to the changing of states of their totem-pole outputs. During this transition, large spikes of current are drawn from the supply voltages. To keep these spikes from interfering with other circuits, bypass capacitors are added between the power-supply line and ground. Capacitors have the property that they pass high-frequency voltages while blocking direct current. When they are placed across the power supply, they provide a path for voltage spikes (high-frequency noise) to get to ground, without actually shorting the supply. These capacitors serve to "despike" the power lines.

A good rule of thumb is to use one disk-ceramic capacitor in the 0.01 to 0.1 µF (microfarad) range for every four TTL packages. Also, if the power-supply lines are very long, additional capacitors should be used. Use a small tantalum capacitor in the 1 to 10 µF range where the power lines enter the board.

It is better to have a lot of small-value capacitors spread around the board than one large-value capacitor at any particular location. Using very large capacitors on the supply lines (several hundred µF) can be catastrophic in some computers. Dynamic memories, such as the 4116, must have sequenced voltage application and removal to prevent destruction. Large capacitors alter the time constants of the built-in power supply and increase the potential for damage. . . .
Steve■

In "Ask BYTE," Steve Ciarcia answers questions on any area of microcomputing. The most representative questions received each month will be answered and published. Do you have a nagging problem? Send your inquiry to:

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If you are a subscriber to The Source, chat with Steve (TCE317) directly. Due to the high volume of inquiries, personal replies cannot be given. Be sure to include "Ask BYTE" in the address.

BYTE's Bits

Broadcast Satellite System Passes Test

Last March, International Phasor Telecom Ltd. and Norsat International Inc., two Canadian high-technology companies, deemed their direct-broadcast encryption system completely compatible with the Anik D Satellite after a series of tests. The tests were part of an ongoing examination of the Phasorlink Encryption System's capabilities. Phasorlink is intended to become an integral part of the broadcast satellite television industry.

The 90-minute test program sent Phasorlink through 14 different operating modes, including direct-broadcast satellite addressability, picture and sound quality control, encryption/decryption algorithms, and Telidon and AT&T videotex transmission. The test was emitted from BCTV facilities in Burnaby, British Columbia, and monitored by satellite broadcasting companies in the U.S. and Canada.■

Books Received

The Apple Connection, James W. Coffron. Berkeley, CA: Sybex, 1982; 263 pages, 42 by 54 cm, softcover, ISBN 0-89588-085-7, $12.95.

Apple II Programmer's Handbook, Richard C. Vile Jr. Englewood Cliffs, NJ: Prentice-Hall, 1982; 276 pages, 21.5 by 27.5 cm, softcover, ISBN 0-13-039198-0, $16.95.

The Art of Programming the ZX Spectrum, M. James. London, England: Bernard Babani Ltd., 1983; 138 pages, 11 by 17.8 cm, softcover, ISBN 0-85934-094-5, £2.50.

Armchair BASIC, Annie Fox and David Fox. Berkeley, CA: Osborne/McGraw-Hill, 1983; 180 pages, 18.5 by 23 cm, softcover, ISBN 0-931988-92-6, $11.95.

Basic APPLE BASIC, James S. Coan. Rochelle Park, NJ: Hayden Book Co., 1982; 237 pages, 17.8 by 24.5 cm, softcover, ISBN 0-8104-5626-5, $12.95.

BASIC For the Apple II, Jerald R. Brown, Leroy Finkel, and Bob Albrecht. New York: John Wiley & Sons, 1982; 410 pages, 17 by 15.5 cm, softcover, ISBN 0471-86596-6, $12.95.

Byteing Deeper Into Your Timex Sinclair 1000, Mark Harrison. New York: John Wiley & Sons, 1982; 160 pages, 17 by 25.3 cm, softcover, ISBN 0471-89888-0, $12.95.

The Computer Coloring Book, Alan Freedman, Irma Lee Morrison, and Eric Jon Nones. Englewood Cliffs, NJ: Prentice-Hall, 1983; 60 pages, 23 by 30.3 cm, softcover, ISBN 0-13-164632-X, $6.95.

Computer Programming For Kids and Other Beginners, Royal Van Horn. Austin, TX: Sterling Swift Publishing Co. (1600 Fortview Rd.), 1982; 144 pages, 21 by 28 cm, spiral bound, ISBN 0-88408-151-6, $9.95. *A Complete Guide For Teachers and Parents*, 141 pages, 26 by 29 cm, loose-leaf bound, ISBN 0-88408-154-0, $9.95.

Courseware in the Classroom: Selecting, Organizing, and Using Educational Software, Ann Lathrop and Bobby Goodson. Menlo Park, CA: Addison-Wesley, 1983; 195 pages, 15.8 by 23 cm, softcover, ISBN 0-201-20007, $10.

Create Word Puzzles With Your Microcomputer, Ernest E. Mau. Rochelle Park, NJ: Hayden Book Co., 1982; 304 pages, 17.7 by 24.6 cm, softcover, ISBN 0-8104-6251-6, $14.95.

Data Base Management Systems, David Kruglinski. Berkeley, CA: Osborne/McGraw-Hill, 1983; 256 pages, 18.5 by 23.5 cm, softcover, ISBN 0-931988-84-5, $16.95.

Digital Integrated Circuits, Joseph Kasper and Steven Feller. Englewood Cliffs, NJ: Prentice-Hall, 1982; 200 pages, 17.3 by 23 cm, softcover, ISBN 0-13-213579-5, $12.95.

Discrete-Time Signals and Systems, Nasir Ahmed and T. Natarajan. Reston, VA: Reston Publishing Co., 1983; 398 pages, 18.5 by 24 cm, hardcover, ISBN 0-8359-1375-9, $25.95.

Doing Business with Supercalc, Stanley R. Trost. Berkeley, CA: Sybex, 1983; 270 pages, 17.8 by 22.8 cm, softcover, ISBN 0-89588-095-4, $12.95.

Electronically Speaking: Computer Speech Generation, John P. Cater. Indianapolis, IN: Howard W. Sams & Co., 1983; 230 pages, 13.5 by 21.5 cm, softcover, ISBN 0-672-21947-6, $14.95.

Foundations of Computer Technology, Joseph C. Giarratano. Indianapolis, IN: Howard W. Sams & Co., 1982; 240 pages, 21.2 by 28 cm, softcover, ISBN 0-672-21814-3, $22.95.

The Genie In the Computer, Rachel Kohl, Laura Karp, and Ethan Signer. New York: John Wiley & Sons, 1982; 169 pages, 21.3 by 28 cm, softcover, ISBN 0-471-87049-8, $12.95.

The HHC User Guide, Jonathan Sachs, Sand River Software, with Rick Meyer. Berkeley, CA: Osborne/McGraw-Hill, 1983; 200 pages, 16.5 by 23.3 cm, softcover, ISBN 0-931988-87-X, $14.95.

How To Buy A Word Processor, Steven Manus and Michael Scriven. Sherman Oaks, CA: Alfred Publishing Co. Inc. (POB 5964), 1982; 62 pages, 25.6 by 66 cm, softcover, ISBN 0-88284-222-6, $2.95.

How to Cope With Computers, Tom Logsdon. Rochelle Park, NJ: Hayden Book Co., 1982; 131 pages, 15 by 23 cm, softcover, ISBN 0-8104-5193-X, $7.95.

IBM BASIC for Business and Home, Robert Funkhouser. Reston, VA: Reston Publishing Co., 1983; 204 pages, 15 by 23 cm, softcover, 0-8359-3018-1, $14.95.

Introduction to Pascal and Structured Design, Nell Dale and David Orshalick. Lexington, MA: D.C. Heath and Co., 1983; 575 pages, 17.3 by 23.3 cm, softcover, ISBN 0-669-04797-X, $17.95.

Legal Care for Your Software, Daniel Remer. Reading, MA: Addison-Wesley Publishing Co., 1982; 247 pages, 21.5 by 28 cm, softcover, ISBN 0-201-06272-0, $19.95.

LOCATE: A Directory for

Purchasers of Law-Office Computer Applications and Software, Bruce D. Heintz, ed. Chicago, IL: American Bar Association Press (1155 East 60th St.), 1982; 74 pages, 21.6 by 28 cm, softcover, ISBN 0-89707-078-X, $28.

Machine-Independent Organic Software Tools (MINT), 2nd ed., M.D. Godfrey, D.F. Hendry, H.J. Hermans, and R.K. Hessenberg. New York: Academic Press, 1982; 370 pages, 15.5 by 23.5 cm, hardcover, ISBN 0-12-286982-6, $25.

Mastering Visicalc, Douglas Hergert. Berkeley, CA: Sybex, 1983; 240 pages, 17.5 by 22.8 cm, softcover, ISBN 0-89588-090-3, $11.95.

Mathematics for Data Processing, 2nd ed., Frank J. Clark. Reston, VA: Reston Publishing Co., 1983; 332 pages, hardcover, ISBN 0-8359-4263-5, $21.95.

Microcomputer Interfacing, Harold S. Stone. Reading, MA: Addison-Wesley Publishing Co., 1982; 383 pages, 16.5 by 24 cm, hardcover, ISBN 0-201-07403-6, $32.95.

New Directions in Computer Design, vol. 1, Saul B. Dinman. Tulsa, OK: Pennwell Books (POB 21288), 1982; 127 pages, 21.5 by 27.5 cm, softcover, ISBN 0-87814-209-6, $19.95.

1982 Semiconductor Memories: An Update, Eugene R. Hnatek. Tulsa, OK: Pennwell Books (POB 21288), 1982; 132 pages, 21.5 by 28 cm, softcover, ISBN 0-87814-197-9, $23.95.

Pocket Computer Primer, Hank Librach. Englewood Cliffs, NJ: Prentice-Hall, 1982; 96 pages, 36 by 54 cm, softcover, ISBN 0-13-683854, $9.95.

Principles of Fortran 77 Programming, Jerrold L. Wagener. New York: John Wiley & Sons, 1980; 370 pages, 50.6 by 66 cm, softcover, ISBN 0-471-04474-1, $19.95.

The Small Computer Connection: Telecommunications for the Home & Office, Neil L. Shapiro. New York: Micro Text/McGraw-Hill, 1983; 190 pages, 15.3 by 22.8 cm, softcover, ISBN 0-07-056412-4, $15.95.

Some Common Pascal Programs, Greg Davidson. Berkeley, CA: Osborne/-McGraw-Hill, 1982; 235 pages, 50 by 65 cm, softcover, ISBN 0-981988-73-X, $14.99.

Timex Sinclair 1000, Robin Jones and Ian Stewart. Cambridge, MA: Birkhäuser Boston Inc. (380 Green St.), 1982; 156 pages, 15.2 by 23 cm, softcover, ISBN 3-7643-3080-5, $10.95.

TRS-80 Programmer's Sourcebook, J. Bradley Flippin, ed. Springfield, VA: OCEAN, 1983; 80 pages, 21.5 by 27.8 cm, softcover, ISBN 0-912043-00-8, $4.95.

The TRS-80 Model III User's Guide, Tony Bove and Leroy Finkel. Somerset, NJ: John Wiley & Sons, 1983; 266 pages, 17 by 25.3 cm, softcover, ISBN 0-471-86242-8, $12.95.

Tools of the Mind, V. Stibic. New York: North-Holland Publishing Co., 1982; 297 pages, 16 by 23 cm, hardcover, ISBN 0-444-86444-X, $35.

Trade Secrets, James Pooley. Berkeley, CA: Osborne/McGraw-Hill, 1982; 145 pages, 16.5 by 23 cm, softcover, ISBN 0-931988-93-4, $11.95.

Understanding Pascal, George Ledin Jr. Sherman Oaks, CA: Alfred Publishing Co Inc. (POB 5964), 1981; 63 pages, 25.6 by 66 cm, softcover, ISBN 0-88284-149-1, $2.95.

Verbal Control with Microcomputers, Mike Rigsby. Blue Ridge Summit, PA: Tab Books, 1982; 304 pages, 13 by 21 cm, softcover, ISBN 0-8306-1468-0, $11.95.

The Visicalc Applications Book, Jack Grushcow. Reston, VA: Reston Publishing Co., 1983; 286 pages, 15.5 by 23.5 cm, hardcover, ISBN 0-8359-8390-0, $19.95.

Your Timex Sinclair 1000 and ZX81, Douglas Hergert. Berkeley, CA: Sybex, 1983; 175 pages, 13.8 by 21 cm, softcover, ISBN 0-89588-099-7, $6.95.

Writing in the Computer Age, Andrew Fluegelman and Jeremy Joan Hewes. Garden City, NY: Anchor Press/Doubleday, 1983; 254 pages, 15 by 23.3 cm, softcover, ISBN 0-385-18125-6, $10.95. ■

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.

Software Received

Apple

Address/Dialer, an address, phone-number, and appointment-management program that automatically dials phone numbers, redials busy numbers, keeps track of appointments, and can print a mailing list of selected names. For the Apple II Plus; floppy disk, $79. Christopher Systems Corp., 2775 Glendower Ave., Los Angeles, CA 90027.

Alybadix, a chess-solving program that includes operation instructions, a simplified version of the Matebadix Intelligent program, and is ideal for solving one to two players' chess problems. For the Apple II; floppy disk. Price not available. Ilkka Blom, Palosaarentie 13-17 C 27, SF-65200 Vaasa 20, Finland.

Apple Typewriter Word Processor, a utility package. A full-function word processor requiring no additional hardware that features unlimited document size, wordwrap and right justification options, mnemonic editing commands, and more. For the Apple II Plus and IIe, floppy disk, Ultra Software Applications, 900 Bellewood Dr. SE, Kentwood, MI 49508.

Bulk Mailer, a direct-marketing program that features mailing-list management with a 32,000-name capacity, duplication search, and other options. For the Apple II; floppy disk, $125. Satori Software, 5507 Woodlawn Ave. N, Seattle, WA 98103.

Crime Wave, a fast-action chase game. Lawlessness runs rampant in this city. Hop into your trusty cruiser and round up would-be bank robbers before their Robot Rammers turn traffic into a demolition derby. For the Apple II; floppy disk, $19.95. Penguin Software, 830 4th Ave., Geneva, IL 60134.

The Golf Handicapper, a program that keeps track of a golfer's overall handicap and stroke and putting averages. For the Apple II Plus and IIe; floppy disk, $19.95. Sunshine Productions, 108 Courtright, San Rafael, CA 94901.

Golfsoft Statistician, a golf-analysis program that lowers the golfer's score by evaluating each stroke on the basis of impact feel, initial and resultant directions, trajectory, and relative distance. For the Apple II Plus; floppy disk, $34.95. Golfsoft Inc., 10333 Balsam Lane, Eden Prairie, MN 55344.

IDS (Integrated Development System). This utility package provides sets of screen management, disk file I/O, and printline formatting subroutines. For the Apple II Plus and IIe; floppy disk, $85. R.R. Michaels Inc., POB 2712, Reston, VA 22090.

Keyshoppe, a grocery-shopping program. Make your weekly grocery shopping more efficient with accurate lists that can save time and money. For the Apple II Plus and IIe; floppy disk, $39.95. Universal Instrumentation, POB 5254, Huntington Beach, CA 92615.

Menu Builder, a menu-writing program. You enter menu titles and file names and the program writes a menu program in Applesoft. It also allows screen formatting and editing and can build a menu directly from the disk catalog. For the Apple II; floppy disk, $9.95. Jim's Software, 384 The Great Road, Bedford, MA 01730.

The Menu Writer, a utility program that lets you execute a file on disk by typing a single keystroke instead of the whole filename. Menus are written in Applesoft BASIC or Integer BASIC. For the Apple II, II Plus, and IIe; floppy disk, $29.95. Micro Unicorn Co., 2156 Mendota Way, San Jose, CA 95113.

New World, a multiplayer educational game for all ages. The year is 1495 and you are in the race for supremacy of the New World. Raise your flag in many colonies, recruit large armies, and return to your country with gold. For the Apple II; floppy disk, $29.95. Automated Simulations/EPYX, 1043 Kiel Court, Sunnyvale, CA 94086.

Quick File II, a utility package that manages files of 150 to 250 records. It allows you to turn your receipts, lists, and schedules into coherent, accessible reports and can print tables, mailing labels, and index cards. For the Apple IIe; floppy disk, $100. Apple Computer Inc., 20525 Mariani Ave., Cupertino, CA 95014.

Softsight, a comprehensive machine-language debugging tool. You can observe, analyze, and control the execution of machine-language programs to understand how they work, optimize them, or locate problems. For the Apple II and IIe; floppy disk, $40. Overdrive Computer Corp., Suite 2102, 1131 University Blvd., Silver Spring, MD 20902.

Speedstat 1, a statistical-analysis system that produces presentation-quality printed reports applicable to all types of research. You can gain immediate access to statistical information without any previous computer experience. For the Apple II; floppy disk, $250. Softcorp International, 229 Huber Village Blvd., Westerville, OH 43081.

Thunderbombs, a fast-action arcade-type game. Out for a cruise in your interstellar cloudship, you are suddenly trapped in a deadly crossfire of alien dronebombs. To destroy the attacking aliens, you must first eliminate their supply ships. For the Apple II; floppy disk, $19.95. Penguin Software (see address above).

Atari

Brain Boggler. Music, sound, and color add to the challenge of unraveling a mysterious color code hidden in the computer's memory. Find it before time runs out. For the Atari 400/800; floppy disk, $16.95. Educational Software Inc., 4565 Cherryvale Ave., Soquel, CA 95073.

The Blade of Blackpoole, an adventure-type game. Recover the magical sword Myraglym from a dangerous, underwater cavern and return it to the altar it was stolen from. For the Atari 800; floppy disk, $39.95. Sirius Software Inc., 10364 Rockingham Dr., Sacramento, CA 95827.

Graphics Machine, a program that allows you to create high-resolution graphics by typing in simple commands such as line, box, circle, polygon, fill, and save-screen. You can retrieve them within five seconds. For the Atari 800; floppy disk, $19.95. Educational Software Inc. (see address above).

Space Games, three arcade-type games. If you are successful in Aliens, Survive, and Robot Attack, you can become a member of the Videowiz Patrol. Requires a joystick. For the Atari 800; floppy disk, $24.95. Educational Software Inc. (see address above).

Spy's Demise, an arcade-type game. Your mission is to reach the top floor of an embassy, avoiding guards in the elevators, and gather pieces of an encoded message strategically hidden on each floor. For the Atari 400/800; floppy disk, $19.95. Penguin Software, 830 4th Ave., Geneva, IL 60134.

Tricky Tutorial #2: Horizontal & Vertical Scrolling, an educational program that teaches you how to scroll text and graphics horizontally, vertically, diagonally, or even partially. Requires a joystick. For the Atari 400/800; floppy disk, $19.95. Educational Software Inc. (see address above).

Twerps, an arcade-type game. As Captain Twerp, you must rescue nine fellow twerps stranded on an asteroid. In your Twerp-Craft, shoot Orbiters, avoid Glingas and Gleepnoks, and land before running out of fuel. For the Atari 800; floppy disk, $34.95. Sirius Software Inc. (see address above).

CP/M

C Compiler, a language-compiler program designed to operate as either a native or cross compiler. It allows C programs to be transported, without change, within a group of Unix-compatible systems. For CP/M-based systems; floppy disk, $350. Telecon Systems, Suite 218, 1155 Meridian Ave., San Jose, CA 95125.

CBASIC Compiler, a utility package of a compiler, link editor, and library that contains features such as structured control statements, functions, and a variety of data types. Other features include parameter passing, local and global variables, and chaining between programs. For CP/M-based systems; floppy disk, $500. Digital Research Inc., 160 Central Ave., POB 579, Pacific Grove, CA 93950.

CP/M Plus, an advanced version of CP/M that manages and supervises a computer's resources, including memory and disk storage, screen, keyboard, printer, and communications devices. It also handles information stored magnetically on disk and can copy files from disk to memory or a printer. For CP/M-based systems; floppy disk, $350. Digital Research Inc. (see address above).

dBRx, machine-language routines that add several mathematical functions such as sine, cosine, arc tangent, and others to enhance dBASE II. For CP/M-based systems; floppy disk, $150. Gryphon Microproducts, POB 6543, Silver Spring, MD 20906.

Display Manager, a utility program that helps programmers and independent software vendors save time by creating and modifying CRT (cathode ray tube) screen displays. Application programs written in a Digital Research language can later reference these screen displays. For CP/M-based systems; floppy disk, $400. Digital Research Inc. (see address above).

General Ledger, an assembly-language program designed for business use. This menu-driven program contains six reports and a breakdown of accounts by departments. For CP/M-based systems; floppy disk, $99.95. Sunflower Software, 13915 Midland Dr., Shawnee, KS 66216.

ICE80 Utility Library, a collection of programming tools that contains character manipulations and scanning, text parsing and stringing, disk input/output, and other functions used when writing assembly language. For CP/M-based systems; floppy disk, $40. Industrial Computing Equipment Corp., Suite B-3, 100 Timber Oak Court, Lynchburg, VA 24502.

Labelpro, a label-printing program that prints up to 100 labels in a variety of sizes. Companies can be selected by customer name, city, state, zip code, lead source, and customer comment. For CP/M-based systems; floppy disk, $175. Compugreen, 3095 D South Peoria #275, Aurora, CO 80014.

Leadpro, a customer/prospect list that can record an unlimited number of comments for each company listed. Most messages can be answered with a single keystroke on this menu-driven program. For CP/M version 2.2-based systems; floppy disk, $195. Compugreen (see address above).

Questext III, a general-purpose system for organizing, storing, and communicating textual information. You can edit from menu prompts without learning command syntax. For CP/M-based systems; floppy disk, $299.95. Information Reduction Research, 1538 Main St., Concord, MA 01742.

Relocation Utility Package, an assembly-language toolkit consisting of four programs for examining the contents of a relocatable module. For CP/M-based systems; floppy disk, $99.95. Microsmith Computer Technology, POB 1473, Elkhart, IN 46515.

Versa-file, a file-management system that creates, edits, and prints key-accessed files. Multiple and customized forms can be created for printing each file and records of files can be sorted before printing. For CP/M-based systems; floppy disk, $69. Analytic Management Systems, 247 High St., Palo Alto, CA 94301.

Commodore

Collision, an arcade-type game in which you maneuver a growing line on the screen, avoiding walls and obstacles while making your opponent crash. Nine levels of difficulty; requires a joystick. For the Commodore 64; floppy disk, $15.95. Topologic, POB 752, Burlington, IA 52601.

Deadly Skies, an arcade-type game. Equipped with a squadron of five helicopters, you must destroy an enemy military base. Action increases with each of 32 play levels. For the Commodore VIC-20, cassette, $39.95. Tronix Publishing Inc., 8295 South La Cienega, Inglewood, CA 90301.

Gold Fever. You assume the role of a gold miner who must gather all the gold in a mine shaft while avoiding runaway box cars, boulders, and claim jumpers. And you must do all this before the oxygen in the mine runs out. For the Commodore VIC-20; cassette, $39.95. Tronix Publishing Inc. (see address above).

MAS-64 Accounting System, an accounting-systems package containing three modules: General Ledger, Accounts Payable/Checkwriting, and Accounts Receivable/Billing. For the Commodore 64; floppy disk, $199 per module. Infodesigns Inc., 6905 Telegraph Rd., Birmingham, MI 48010.

Scorpion, a game in which a scorpion struggles against dragons, frogs, Venus's-flytraps, stalkers, worms, and pods. To survive, the scorpion must gather eggs and stunned frogs for food. For the Commodore VIC-20; cassette, $39.95. Tronix Publishing Inc. (see address above).

Secure, a program that produces 256 encryptions of single programs at random and is compatible with composite, BASIC, and machine codes. Use one key to encrypt many programs or original keys can be created for each piece of software. For the CBM 4000/8000; floppy disk, $100. Distribution Unlimited, Department B, POB 81702, San Diego, CA 92138.

IBM Personal Computer

CP/M-86, an operating system that manages information stored magnetically on disk by grouping it into files of programs and data. This program can copy files from a disk to memory or to a printer. For the IBM Personal Computer; floppy disk, $60. Digital Research Inc., POB 579, 160 Central Ave., Pacific Grove, CA 93950.

Concurrent CP/M-86, a single-user, multitasking operating system that lets you run multiple programs simultaneously by dividing tasks between virtual consoles. For the IBM Personal Computer; floppy disk, $350. Digital Research Inc. (see address above).

Cyborg, a science-fiction adventure game. With half of your body transformed into a machine, you might as well accept the mission you are offered, rather than endure being ostracized by friends and family. For the IBM Personal Computer; floppy disk, $34.95. Sentient Software Inc., POB 4929, Aspen, CO 81612.

The Executive Package, a collection of more than 50 BASIC and Visicalc spreadsheet programs and tables to help executives exercise their problem-solving capabilities. The programs analyze productivity, corporate growth, and other aspects of your business. For the IBM Personal Computer; floppy disk, $145. Alpha Software Corp., 12 New England Executive Park, Burlington, MA 01803.

FCpak, an engineering program. This fuel-cell library is used to compute the exit conditions of acid, alkaline, and molten carbonate fuel cells. It also computes the cell current density at the system-design point. For the IBM Personal Computer; floppy disk, $375. Physical Sciences Inc., Research Park, POB 3100, Andover, MA 01810.

Graphics Utility, a graphics-generator/editor program. You can create character sets, shapes for animation, and games for display on your graphics monitor. Characters and pictures can be stored on disk and printed. For the IBM Personal Computer; floppy disk, $55. Savant Software Inc., POB 440278, Houston, TX 77244.

Lazycoder Screen, an electronic-blackboard program. Move the cursor to any position and type what you want—where you want it. Thirty-five built-in functions will help you design images or data-entry screens. For the IBM Personal Computer; floppy disk, $125. Nelson Data Resources Inc., Suite 118, 900 South 74th Plaza, Omaha, NE 68114.

Software Received

Memory Shift, a utility package that transforms your IBM Personal Computer into two separate computers, providing instant access to multiple programs. You can shift from task to task with parallel residency. For the IBM Personal Computer; floppy disk, $99. North American Business Systems Inc., Suite 202, 677 Craig Rd., St. Louis, MO 63141.

Optioncalc, a financial/investment program. When you input current financial data, you can calculate the theoretical value for call-and-put options based on the Black and Scholes model, call price, and an efficient marketplace. For the IBM Personal Computer; floppy disk, $65. Savant Software Inc. (see address above).

Pdrop, an engineering program designed to calculate the pressure drop of fluids in circular pipes. The program treats liquids as incompressible fluids, gases as compressible fluids, and contains built-in viscosity and density properties for water, steam, and air. For the IBM Personal Computer; floppy disk, $75. Physical Sciences Inc. (see address above).

Pascal/MT+86, a version of the language that supports the International Standards Organization (ISO) standard DPS/7185, including variant records, sets, typed and text files, passing procedures, and functions as parameters. For the IBM Personal Computer; floppy disk, $400. Digital Research Inc. (see address above).

The Permanent Portfolio Analyzer, a utility program that lets you enter a large portfolio of investments and analyze them over a ten-year period. Choose from level inflation, rising inflation, runaway inflation, and more. For the IBM Personal Computer; floppy disk, $295. C.R. Hunter & Associates, 1527 Northwood Dr., Cincinnati, OH 45237.

Reacpak, an engineering program containing several modules used to compute the exit conditions from such combustibles as methanol reformers, burners, and shift converters. For the IBM Personal Computer; floppy disk, $325. Physical Sciences Inc. (see address above).

Speed Programming Package, a set of software tools that helps you enter **Pascal/MT+86** programs efficiently and catch syntax errors before sending them to the compiler. For the IBM Personal Computer; floppy disk, $200. Digital Research Inc. (see address above.)

The Thinker, an electronic-spreadsheet program that is straightforward enough for the novice to learn to use in less than one hour. You create tables of text and numeric relations that can be used for anything from household budgets to complex mathematical or scientific models. For the IBM Personal Computer; floppy disk, $75. Texasoft, 3415 Westminster, Dallas, TX 75225.

Versatext, a word-processing/database program. Features include full cursor control, discretionary formatting, prompting, updating, editing, and other capabilities. For the IBM Personal Computer; floppy disk, $199.95. Texasoft (see address above).

Wordflex, a word-processing/text-editing package. User instructions contain 12 chapters describing its functions and options. A reference section summarizes all the commands alphabetically. For the IBM Personal Computer; floppy disk, $100. NEMCO, 9 Walnut St., Rutherford, NJ 07070.

TRS-80

EDM, an editing program. A full-screen, wide-range file editor that can be customized to an assembly-language editor, a high-level language editor, or a word-processing system. For the TRS-80 Models I and III; floppy disk, $149. The Alternate Source, 704 North Pennsylvania Ave., Lansing, MI 48906.

Enigma, a file-encryption program. A combinaton machine-language program and BASIC driver that will encrypt any disk file so that only those with a pass key can reconstruct the file. For the TRS-80 Models I and III; floppy disk, $59.95. Casler Computing, 2929 El Paso Ave., Simi Valley, CA 93063.

FORTRAN Utilities, a utility program that provides the FORTRAN programmer with library subroutines and functions permitting the use of cursor addressing for screen input and output. Other routines include program chaining and system-date access. For the TRS-80 Model II; floppy disk, $70. David Ray CPA, Software Products, 605 Caravaca Dr., Garland, TX 75043.

General Ledger, an accounting package containing programs such as password protection, direct posting, cash journal, transactions by month or year to date, budget files, amortization, and more. It can hold up to 700 accounts. For the TRS-80 Model II; floppy disk, $600. International Software Sales Inc., POB 223, Newtonville, NY 12128.

Matrix Subroutines, educational and engineering subroutines that extend ROM by allowing you to call the standard matrix operations from BASIC: regular mathematical functions, transpose, inverse, and more. For the TRS-80 Models I and III; floppy disk, $19.95. PAB Software Inc., POB 15397, Fort Wayne, IN 46885.

New World, a multiplayer educational game (see description under Apple). For the TRS-80 Models I and III; floppy disk, $29.95. Automated Simulations/EPYX, 1043 Kiel Court, Sunnyvale, CA 94086.

RSCOBOL Utilities, a utility program that supplies library routines to COBOL programmers. It implements useful supervisor calls such as file copy/rename/delete, CRT-(cathode ray tube) and printer-control capabilities. For the TRS-80 Model II; floppy disk, $120. David Ray CPA, Software Products (see address above).

Stockline, a technical-analysis package for the stock-market trader. This package concentrates on the tedious task of analytical charting. Your time is saved for reading and interpreting the charts. For the TRS-80 Models I and III; floppy disk, $149.95. Think Software Inc., 572-810 West Broadway, Vancouver, British Columbia V5Z 4C9, Canada.

Wall Street TAP, a communications package designed to complement stock-market analysis programs and **Stockline**. It gathers and stores stock-index data obtained via Compuserve. For the TRS-80 Models I and III; floppy disk, $59.95. Think Software Inc. (see address above).

Texas Instruments

Chemtutor 1, an educational program containing a basic chemistry quiz that runs with Extended BASIC. It is the first in a series of seven programs designed to cover a year of high school chemistry. For the Texas Instruments 99/4A; cassette, $10. Data Systems, 2214 West Iowa, Chicago, IL 60622.

Hobbyist Game Pac I. A collection of 12 inexpensive games written in BASIC and Extended BASIC, using sound, color, and graphics. Requires a joystick. For the Texas Instruments 99/4A; cassette, $9.95. Microworld, 145 East Norman Dr., Palatine, IL 60067.

Personal Tax Organizer, a tool to record detailed, personal tax deductions for the 1040 Schedule A tax form. Deductions can be reviewed any time. For the Texas Instruments 99/4A; cassette, $12.98. Design Strategies, 69-B Bethel Church Rd., Jackson, NJ 08527.

Other Computers

XFORTH, an implementation of the FORTH-79 language that uses a simple one-word call to return to Sinclair BASIC. Requires 16K bytes of memory. For the Timex/Sinclair 1000 and ZX81, cassette, $25. Hawg Wild Software, 7575 Cantrell/21, Little Rock, AR 72207. ■

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.

BYTE's Bits

Conference Proceedings Available

The conference proceedings from the Second Annual Penn State Microcomputer Information Exchange Conference have been made available. The papers that were presented during the conference concentrated on educational topics for kindergarten through college levels. Topics covered include Logo, computer-aided instruction, teaching music, managing curricula with microcomputers, computer camps, and staff development for computer literacy.

The proceedings cost $10. Contact Dr. Michael J. Streibel, Instructional Systems Program, 179 Chambers Building, The Pennsylvania State University, University Park, PA 16802. ■

Event Queue

July 1983

July

Continuing Engineering Education Courses, George Washington University, Washington, DC. Among the courses offered are "Microcomputers in Control Systems Including Interfacing Methods," "Reliability of Computer Software and Computing Networks," and "Computer Memory Systems." Fees range from $685 to $855. For details, contact Douglas Green, Continuing Engineering Education, George Washington University, Washington, DC 20052, (800) 424-9773; in the District of Columbia, (202) 676-8512.

July

Software Workshops in MMSFORTH, Boston metropolitan area. These workshops are public versions of the professional training Miller Microcomputer Services (MMS) offers to client companies in support of its MMSFORTH product line. The fee for a one-day, beginner-level course is $150. Full details are available from Miller Microcomputer Services, 61 Lake Shore Rd., Natick, MA 01760, (617) 653-6136.

July

Technical Courses from Zilog, Campbell, CA. A wide variety of such courses as "The Computer: A Survey," "C Programming," and "ZEUS/System 8000 User Course" are offered. Fees range from $525 to $875. For a complete schedule, contact Zilog Inc., Training and Education Department, 1315 Dell Ave., Campbell, CA 95008, (408) 370-8092.

July-August

Courses in C Language and Unix, various sites throughout the U.S. Three 5-day courses are offered by Plum Hall Inc. The "C Programming Workshop" is a hands-on course that covers all aspects of the C language for individuals able to program in another language. The "Advanced C Topics Seminar" covers efficiency, portability, readability, debugging, packaging, and interfacing. The "Unix Workshop" is an introductory course that focuses on software development. For further details, contact Joan Hall, Plum Hall Inc., 1 Spruce Ave., Cardiff, NJ 08232, (609) 927-3770.

July-August

Engineering Summer Conferences, Chrysler Center for Continuing Engineering Education, North Campus, University of Michigan, Ann Arbor. More than 25 courses are offered in aerospace, chemical, civil, environmental, electrical, fluid, computer, information, and control engineering. One-week course fees range from $550 to $775; two-week courses are $875. For course outlines and registration details, contact Engineering Summer Conferences, 200 Chrysler Center, North Campus, University of Michigan, Ann Arbor, MI 48109, (313) 764-8490.

July-October

Courses from the AMA, various sites throughout the U.S. The American Management Associations (AMA) offers an on-going series of seminars in such areas as human resources, information systems, and manufacturing and technology management. In-house development and multimedia training programs are offered. For information on AMA membership or seminar particulars in the Eastern U.S.: AMA, 135 West 50th St., New York, NY 10020, (212) 586-8100; in the Midwest or South: AMA, 8655 West Higgins Rd., Chicago, IL 60631, (312) 693-5511; and on the West Coast: AMA, 177 Post St. #350, San Francisco, CA 94108, (415) 397-7610.

July-October

Repair of Microcomputer-based Equipment, various sites throughout the U.S. and Canada. This lecture/laboratory sequence is intended for field-service personnel, engineers, and technical writers. The seminar describes general servicing practices that are applied to the subsystems of any microprocessor family. For further information, contact the Registrar, Testek Consultants Inc., 1000 North Patton St., Arlington Heights, IL 60004, (312) 577-2134.

July-November

Courses from Integrated Computer Systems, various sites throughout the U.S. Course titles include "Computerized Robots," "Software Project Management," "Hands-On Pascal Workshop," "Defining Software Requirements, Specifications, and Tests," and "Structured Design and Programming." Fees range from $695 to $845. For information, contact Ruth Dordick, Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, or call (213) 450-2060.

July-December

Intensive Two-Day Seminars for Professional Development, Worcester Polytechnic Institute, Boston metropolitan area and Hartford and Stamford, CT. Among the seminars being offered are "The Engineer as Manager," "Inventory Control: Using Computers," and "Fundamentals of Data Processing." For in-house seminar information, call Robert J. Hall at (617) 793-5574. For a seminar bulletin and registration information, contact Ginny Bazarian, Office of Continuing Education, Higgins House, Worcester Polytechnic Institute, Worcester, MA 01609, (617) 793-5517.

July-December

Systems Development Documentation: Forms Method, various sites throughout the U.S. and Canada. This one-day seminar is designed for data-processing managers, project leaders, programmers, and technical writers. Topics to be covered include system design documentation, format and style guidelines, and options for end-document publication. The course fee is $155, which includes all materials. In-company presentations are available for groups of 10 or more. For details, contact Technical Communications Associates Inc., 1250 Oakmead Parkway #210, Sunnyvale, CA 94086, (800) 227-3800, ext. 977; in California, (800) 792-0990, ext. 977, or (408) 737-2665.

July 10-11

The Role of Microcomputers in Music Education, Triton College, River Grove, IL. Seminars, workshops, demonstrations, and manufacturer displays will highlight this event. Topics of interest include ear training, improvisation, computer basics for the teacher, choosing the right computer, and using computers in music for the disabled. The fee is $25 a day; $40 for both days. For details, contact Michael Ferrelli, Triton College, 2000 Fifth Ave., River Grove, IL 60171.

July 11-13
The 1983 Summer Computer Simulation Conference, Hyatt Regency, Vancouver, British Columbia, Canada. Full details are available from the Society for Computer Simulation, POB 2228, La Jolla, CA 92038, (714) 459-3888.

July 11-15
Technology Opportunity Conference, Los Angeles, CA. This conference will focus 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.

July 12-14
Audio-Visual America, Hyatt Regency Hotel, Chicago, IL. The second annual Audio-Visual America will feature hardware and software exhibits, screenings of shows, and approximately 60 workshops on planning, production, and management. For details, contact A-V America, IF Associates, 3150 Spring St., Fairfax, VA 22031, (703) 273-8272.

July 13-15
Personal Computers for Managers, San Francisco, CA. This seminar is designed for both technical and nontechnical managers involved with sales, marketing, production, personnel, or education. Topics to be addressed include electronic worksheets and spreadsheet reports, selecting a personal computer, and creating management graphs and charts. The fee is $695, which includes guide books and a Timex/Sinclair computer. For information, contact Personal Computer Management Association, 11928 North Earlham, Orange, CA 92669, (714) 532-6717.

July 14-15
Computer Graphics in Design, Seattle, WA. This seminar begins with the historical development of computer images and an introduction to graphics programming. It ends with participants using a digital-art system to create charts, graphs, and free-form art. It's sponsored by the Dynamic Graphics Educational Foundation (DGEF). For a catalog and registration details, contact DGEF, Department R, 6000 North Forest Park Dr., POB 1901, Peoria, IL 61656, (309) 688-8866, ext. 505.

July 14-16
Personal Computer Interfacing and Scientific Instrument Automation, Charleston, SC. This workshop provides each participant with hands-on experience in wiring and testing interfaces. The fee is $395. Call or write Dr. Linda Leffel, C.E.C., Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, (703) 961-4848.

July 18-19
Fundamentals of Data Processing for the Non Data-Processing Executive, Chicago, IL. Major topics to be covered include computer technology, the functions of an information system, the development of applications software, and the costs and benefits of information systems. This seminar is presented by the Wharton School of the University of Pennsylvania. The fee is $795. In-house programs are available. For details, contact Wharton FDP Seminar, Registrar-Processing Center, 30-30 Borden Ave., Long Island City, NY 11101, (212) 392-9441.

July 18-19
Productivity '83, Westin Hotel, Seattle, WA. Hewlett-Packard's hands-on showcase of more than 32 computer products and 17 seminars is designed for both professionals and novices and aims to provide solutions to problems confronting the data processing industry. For details, call (800) 453-9500.

July 18-28
Microcomputer-based Instrumentation for Schools, Middletown, OH. This workshop is designed for science and mathematics teachers in both secondary and undergraduate levels. Participants will learn how to construct and use simple, low-cost analog-to-digital and digital-to-analog converters for monitoring and controlling physical phenomena in classrooms and laboratories. Contact Bill Rouse, 301E McGuffey Hall, Miami University, Oxford, OH 45056, (513) 529-2141.

July 20-21
Token-based Local Networks, Washington, DC. This program is the second of four parts in the Architecture Technology Corporation's 1983 Forum Series. The series will bring together manufacturers and users of local network schemes to exchange information in an informal setting. The format includes presentations, panel discussions, and a technological summary. The fee is $395 per person. For details, contact the Architecture Technology Corp., POB 24344, Minneapolis, MN 55424, (612) 935-2035.

July 21-22
Shared Information Management Seminar, Hyatt Regency, Cambridge, MA. This seminar is designed for department heads, information-center managers, senior applications personnel, and data-processing support coordinators. It strives to explain how to manage the development of new systems with reduced risk and how to introduce new flexibility into data processing. The fee is $455. Group discounts are available. For further information, contact Bob Mishler, Boeing Computer Services Co., Education and Training Division, POB 24346, Mail Stop 9A-90, Seattle, WA 98124, (800) 342-7700; in Washington, call collect, (206) 575-7700.

July 25-27
The 1983 Conference of the International Business Schools Computer Users Group (IBSCUG), University of Waterloo, Ontario, Canada. Faculty, staff, and practitioners from business schools will investigate current developments in hardware, software, and the applications of computers to business education. For information, contact Anthony Wensley, Accounting Group, University of Waterloo, Ontario N2L 3G1, Canada, (519) 885-1211, ext 2755.

July 25-28
Softfair, Hyatt Regency, Crystal City, Arlington, VA. This seminar, sponsored by the Institute for Electrical and Electronics Engineers (IEEE) Computer Society, covers software development tools, techniques, and alternatives. For details, contact Softfair, POB 639, Silver Spring, MD 20901, or call (301) 589-8142.

July 25-28
The World of CAD/CAM, Dunfey's Resort, Hyannis, MA. This seminar provides an overview of how manufacturing will change as the automated factory becomes a reality. It will consist of four one-day presentations in computer-aided engineering, design, manufacturing, and computer-integrated manufacturing. For a brochure, write or call the Center for Manufacturing Technology, 4170 Crossgate Dr., Cincinnati, OH 45236, (513) 791-8801.

July 25-29
Robot Manipulators, Computer Vision, and Automated Assembly, Artificial Intelligence Laboratory, Massachusetts Institute of Technology, Cambridge, MA. The emphasis of this short course will be on developing strategies for the solution of problems that will arise in advanced automation: sensing, spatial reasoning, and manipulation. The use of current industrial robots and binary vision systems will be covered. For details, contact the Director of the Summer Session, Room E19-356, Massachusetts Institute of Technology, Cambridge, MA 02139.

July 25-29
SIGGRAPH '83, Detroit, MI. This is the tenth annual conference on computer graphics and interactive techniques sponsored by the Special-Interest Group on Computer Graphics of the Association for Computing Machinery (SIGGRAPH ACM). This show features tutorials, films and video tapes, exhibits of computing equipment, and a formal technical program. For full details, contact the SIGGRAPH '83 Conference Office, 111 East Wacker Dr., Chicago, IL 60601, (312) 644-6610.

July 26-29
The Third Computer-based Music Instruction Workshop, University of Illinois, Urbana-Champaign. This workshop serves as an introduction to the uses of computers in music instruction. Hardware, software, and teaching strategies appropriate to computer-based music instruction will be covered. The cost is $100. Contact Dale Kimpton, CEPS in Music, School of Music, University of Illinois, Urbana, IL 61801.

July 27-29
Personal Computers for Managers, Boston, MA. For details, see July 13-15.

August 1983

August-December
IEEE Conferences and Meetings, various sites around the world. The Institute for Electrical and Electronics Engineers (IEEE) sponsors conferences, meetings, and workshops covering high-technology issues. For details, contact the IEEE Computer Society, Suite 300, 1109 Spring St., Silver Spring, MD 20910, (301) 589-8142.

August 1-5
Logon '83, Montana State University, Bozeman. "Implications, Not Applications" is the theme for this conference on computer technology, mythology, and literacy. Subjects to be explored include "Women and Technology," "The Sacred Axis: Where Mythology Meets Technology," "Computers and the Disabled," and "The Inhuman Dimension of Computer Technology." For further details, contact Michael Sexson, English Department, Montana State University, Bozeman, MT 59717, (406) 994-3768.

August 1-19
International Program in Research and Development Management, Battelle Laboratories, Columbus, OH. This program is intended for middle-level managers responsible for research and development activities in industry and government. The principles and techniques of

productive research and development management will be emphasized. Topics of interest include the philospohy of management, planning, staff development, and evaluating. Contact Dr. William Hitt, Battelle's Columbus Laboratories, 505 King Ave., Columbus, OH 43201, (614) 424-7176.

August 2-4
Microprocessor Background for Management Personnel, University of California, Berkeley. The fee for this course is $565. Full details are available from Continuing Education in Engineering, Department 532N, University of California Extension, 2223 Fulton St., Berkeley, CA 94720, (415) 642-4151.

August 7-10
Computers in Chemical Education Workshop VI, Richmond, KY and Lawrence, KS. Short courses and informal discussions in topics involving computers and chemical education for all levels of computer expertise are being offered with hands-on instruction. The fee is $115. Discounts are available. For details, write to Dr. Victor I. Bendall, Department of Chemistry, Moore 337, Eastern Kentucky University, Richmond, KY 40475.

August 7-10
The 1983 International Computers in Engineering Conference and Exhibit, Chicago Marriott Hotel, Chicago, IL. The exhibit portion of this event is tailored for the mechanical engineer involved in computer applications and technology. In the conference portion, more than 60 technical sessions covering computer-aided design, engineering software and hardware, and robotics and automation are planned. Contact the American Society of Mechanical Engineers, 345 East 47th St., New York, NY 10017, (212) 705-7100 for exhibit information and (212) 705-7795 for conference information.

August 8-12
Contemporary Data Communication Networks: Planning Analysis and Design, Chrysler Center, North Campus, University of Michigan, Ann Arbor. This conference presents alternative networking strategies for computer systems that use data networks. The fee is $700. Contact Continuing Engineering Education, College of Engineering, 300 Chrysler Center, North Campus, University of Michigan, Ann Arbor, MI 48109, (313) 764-8490.

August 8-12
The Eighth International Joint Conference on Artificial Intelligence–IJCAI-83, Karlsruhe, West Germany. This conference seeks to promote scientific interchange within and among all subfields of artificial intelligence research. Papers will address such topics as automatic programming, expert systems, knowledge representation, planning and search, and system support. Contact Saul Amarel, Computer Science Department, Hill Center, Busch Campus, Rutgers University, New Brunswick, NJ 08903, (201) 932-3546. In West Germany, contact Joerg Siekmann, Institut fuer Informatik, Universitaet Karlsruhe, Postfach 6380, D-7500 Karlsruhe 1, West Germany; tel: (49-721) 608-3977.

August 9-13
Individualized Language

Teaching through Microcomputer-assisted Instruction, Boston, MA. This seminar will provide hands-on experience and will cover the theoretical background and uses of microcomputer-assisted language instruction. Contact Ms. Anita Mires, American Language Academy, Suite 200, 11426 Rockville Pike, Rockville, MD 20852, (301) 984-3400.

August 10-12
Microcomputers and High Technology in Vocational Education Conference, Concourse Hotel, Madison, WI. Beginning and advanced classes on microcomputers, presentations on vocational education programs, and software exhibits will be featured. For details, contact Judy Rodenstein or Roger Lambert, Vocational Studies Center, 964 Educational Sciences Building, University of Wisconsin, 1025 West Johnson St., Madison, WI 53706, (608) 263-4367 or 263-2704.

August 11-13
Personal Computer Interfacing and Scientific Instrument Automation, Williamsburg, VA. For details, see July 14-16.

August 16-19
Landsat: Sensor Design & Operation, University of California, Santa Barbara. This course is intended for users of remote-sensor data, including geographers, geologists, and engineers. It covers such topics as sensor requirements and user needs, sensor-design principles and tradeoffs, and multispectral-scanner and thematic-mapper operation. It's cosponsored by the Santa Barbara Research Center and the National Oceanic and Atmospheric Administration. The fee is $450. For a brochure, contact J. Weisman, University of California Extension, Santa Barbara, CA 93106, (805) 961-3697.

August 18-19
Computer Literacy for Lawyers, Denver, CO. This seminar is intended to introduce attorneys to basic computer concepts and their application to the practice of law. Topics will include the specific uses, costs, and benefits of using computers in legal practice, The fee is $550, which includes reference materials. Group discounts are available. For further information, contact Kathryn Mann, Center for Legal Studies, 1926 Arch St., Philadelphia, PA 19103, (215) 732-6999.

August 21-26
The Fourth World Congress on Medical Informatics–MEDINFO 83, RAI International Congress and Exhibition Centre, Amsterdam, The Netherlands. This event combines scientific, technical, and social programs. Approximately 300 scientific papers will be presented on health and hospital systems, clinical laboratory systems, imaging, nursing applications, and preventive and occupational care. Demonstrations, product exhibits, film and video sessions, tours, workshops, and special-interest meetings will be held. The language throughout the conference will be English. Further details are available from the MEDINFO 83 Congress Office, Enschedepad 41-43, NL-1324 GB Almere-Stad, The Netherlands.

August 22-26
The National Conference on Artificial Intelligence–AAAI-83, Washington Hilton Hotel, Washington, DC.

Circle 86 on inquiry card.

This conference is sponsored by the American Association for Artificial Intelligence (AAAI). Displays of computer hardware and software, formal presentations, and the Fredkin Chess Prize Competition highlight this conference. Contact Claudia Mazzetti, AAAI, 445 Burgess Dr., Menlo Park, CA 94025, (415) 328-3123.

August 23-24
Indycon '83, Convention Center, Indianapolis, IN. This conference and exhibition features more than 35 technical sessions and 300 exhibition booths devoted to microcomputers and electronic components. Contact Indycon '83, POB 40312, Indianapolis, IN 46260, (317) 875-7711.

August 25-26
Fundamentals of Data Processing for the Non-Data-Processing Executive, Washington, DC. For details, see July 18-19.

August 26-28
The First IBM PC Faire, Civic Auditorium and Brooks Hall, San Francisco, CA. The focus of this fair will be on hardware, software, and applications for the IBM Personal Computer. Technical conferences, formal papers, product expositions, and special-interest group meetings will be held. For details, contact IBM PC Faire, 345 Swett Rd., Woodside, CA 94062, (415) 851-7077.

August 26-September 3
The International Telecommunications, Scientific, and Technical Expoconference-Telexpo China 1983, Foreign Trade Center, Guangzhou (Canton), Jiangxi Province, People's Republic of China. The theme of this show of communications equipment is "An Integrated Telecommunications System for China." Displays will include aerospace equipment, computers, and peripherals. Additional information is available from AVP Expositions Co. Ltd., Suite 13, 13/F, Block A, Wahkai Industrial Center, 221 Texaco Rd., NT Hong Kong; tel: 0-239003; Telex: 40725 AVPEX HX.

August 29-31
DBMS-M[4] Systems, Washington, DC. For details, contact the Continuing Education Institute, Oliver's Carriage House, 5410 Leaf Treader Way, Columbia, MD 21044, (301) 596-0111; on the West Coast, (213) 824-9545.

September 1983

September-November
Computer Showcase Expos, various sites throughout the U.S. This popular show will bring together sellers and individual users of small computer systems. For details, contact The Interface Group, 160 Speen St., POB 927, Framingham, MA 01701, (800) 225-4620; in Massachusetts, (617) 879-4502.

September-December
Software Workshops in MMSFORTH, Boston metropolitan area. These workshops are public versions of the professional training Miller Microcomputer Services (MMS) offers to client companies 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.

September-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.

September 1-2

The First Meeting of the European Chapter of the Association for Computational Linguistics, University of Pisa, Italy. A variety of formal papers will address such topics as syntax, parsing, and language generation; speech analysis and synthesis; and software tools and programming languages for computational linguistics. Contact Harold Somers, Centre for Computational Linguistics, UMIST, POB 88, Manchester M60 1QD, England.

September 6-10

Asian International Electricals, Electronics, and Communications Exhibition '83–Elecom Asia '83, Stadium Negara, Kuala Lumpur, Malaysia. This trade show serves as a showcase for a wide spectrum of high-technology equipment and materials. Government ministers from the five ASEAN (Association of Southeast Asian Nations) countries (Indonesia, Malaysia, Philippines, Singapore, and Thailand) will attend. For details, contact Technology Marketing Analysis Corp., Suite 428, 680 Beach St., San Francisco, CA 94109, (415) 474-3000. In Malaysia, contact ISE Management (M) SDN BHD, 3-A Jalan SS 24/8, Taman Megah, Petaling Jaya, Selangor, Malaysia; tel: 749377; Telex: MA 37204 AKMISE.

September 8-10

Personal Computer Interfacing and Scientific Instrument Automation, Greensboro, NC. For details, see July 14-16.

September 13-15

AUTOFACT EUROPE Conference and Exhibition, Palexpo Exhibition Center, Geneva, Switzerland. This conference, cosponsored by the Society of Manufacturing Engineers (SME) and the Institution of Production Engineers of London, England, will focus on the technologies of automated and computer-integrated manufacturing for European production. Technical sessions will discuss both theory and applications strategies. A complementary products display will be featured. Contact the Society of Manufacturing Engineers, Public Relations Department, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-0777.

September 13-15

Midcon/83 & Mini/Micro-Midwest/83, Chicago, IL. Topics on the professional program include computer simulation, energy management, laser applications, and printed-circuit-board technology. An exhibit area is planned. For further information, contact Electronic Conventions Inc., 8110 Airport Blvd., Los Angeles, CA 90045, (213) 772-2965.

September 13-15

Peripherals '83, Moscone Center, San Francisco, CA. Full details are available from Cahners Exposition Group, Cahners Plaza, 1350 East Touhy Ave., POB 5060, Des Plaines, IL 60018, (312) 299-9311.

September 14-16

Euromicro '83, Madrid, Spain. This ninth annual symposium will cover microprocessing and programming. Speeches will address economic and social aspects of microprocessors and trends in VLSI (very large-scale integration) technology. Tutorials, seminars, and an exhibition are planned. The highlight of this event is the Euromouse contest, in which mechanical mice from around the world race around a maze. A complete program is available from Euromicro, TH Twente, POB 217, Department INF, Room A312, 7500 AE Enschede, The Netherlands; tel: (31) (53) 338799; Telex: 44200 Thes.

September 15-16

Ethernet-type Local Networks, San Francisco, CA. This is the third program in the four-part Architecture Technology Corporation 1983 Forum Series. The series will bring together manufacturers and users of local network schemes to exchange 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.

September 15-16

The Second Annual Indiana Computer Expo, Convention Center, Indianapolis, IN. This exposition is designed for business end users interested in mini- and microcomputers, software, word processing, graphics, services, and peripherals. Contact Ernie Kerns & Associates, Trade Show Department, Suite 201, 2555 East 55th Place, Indianapolis, IN 46220, (317) 259-8111.

September 16-18

The First Annual Heart of Texas Computer Show, Convention Center, San Antonio, TX. This show will emphasize small-business systems for financial and inventory control, agri-business, education, and personal needs. More than 200 hardware, software, and peripheral vendors will display their wares. Show details are available from Robin G. Mann, Heart of Texas, POB 12094, San Antonio, TX 78212, (512) 226-4636.

September 19-23

The Ninth World Computer Congress - IFIP '83, Paris, France. This event, sponsored by the International Federation for Information Processing (IFIP), is held in conjunction with SICOB, the major French computer exposition. Formal papers and panel sessions will cover such areas as computer hardware and software, theoretical foundations of information processing, networks, and communications. For full program details, contact the U.S. Committee for IFIP '83, Dorn Computer Consultants, 25 East 86th St., New York, NY 10028, (212) 427-7460.

September 20-21

Data Storage 83, Marriott Hotel, Santa Clara, CA. This international forum covers industry issues and areas of change in data-storage equipment and applications. The fee is $850. Contact Cartlidge & Associates Inc., Suite 205, 4030 Moorpark Ave., San Jose, CA 95117, (408) 554-6644.

September 21-22

Business-Expo, Boston, MA. This show serves as a showcase for office equipment ranging from computers to coffee machines. More than 20 seminars are presented. Address inquiries to Business-Expo, 702 East Northland Towers, 15565 Northland Dr., Southfield, MI 48075, (313) 569-8280.

September 26-28

Maecon/83, Kansas City, MO. This electronic show and convention explores such topics as aerospace electronics, computer peripherals, laser technology, and personal computing. Contact Electronic Conventions Inc., 8110 Airport Blvd., Los Angeles, CA 90045, (213) 772-2965.

September 26-29
The World of CAD/CAM, Boca Raton Resort Hotel, FL. For details, see July 25-28.

September 26-30
Compcon Fall '83, Marriott Crystal Gateway Hotel, Arlington, VA. The theme of this show is "Delivering Computer Power to End Users." It features technical papers and panel sessions that address a variety of computer and computer-network issues. It is sponsored by the Institute of Electrical and Electronics Engineers (IEEE) Computer Society. For more information, contact Compcon Fall '83, POB 639, Silver Spring, MD 20901, (301) 589-8142.

September 26-30
Conference on Networks and Electronic Office Systems, University of Reading, Berkshire, England. This conference will provide a forum for the exchange of information and for discussion of recent and future developments relating to networks and electronic office systems. Further information is available from the Conference Secretariat, Institution of Electronic and Radio Engineers, 99 Gower St., London WC1E 6AZ, England; tel: 01-388 3071; Telex: Instrad London WC1.

September 26-30
Expo Beirut '83, Beirut, Lebanon. This is Lebanon's first international reconstruction/development exposition and conference after eight years of civil war. Topics to be covered include contruction, transportation, communications, agriculture, computer hardware and software, metallurgy, textiles, and automated equipment. Further details are available from Show-Tech International Inc., 950 Third Ave., New York, NY 10022.

September 28-29
Ottawa Computer and Office Automation Show, Civic Centre, Ottawa, Ontario, Canada. For details, contact Industrial Trade Shows of Canada, 20 Butterick Rd., Toronto, Ontario M8W 3Z8, Canada, (416) 252-7791.

September 29-October 1
CP/M '83 East, Hynes Auditorium, Boston, MA. For information on this conference and exposition, contact Northeast Expositions Inc., 826 Boylston St., Chestnut Hill, MA 02167, (800) 343-2222; in Massachusetts, (617) 739-2000. ■

In order to gain optimal coverage of your organization's computer conferences, seminars, workshops, courses, etc, notice should reach our office at least three months in advance of the date of the event. Entries should be sent to: Event Queue, BYTE Publications, POB 372, Hancock NH 03449. Each month we publish the current contents of the queue for the month of the cover date and the two following calendar months. Thus a given event may appear as many as three times in this section if it is sent to us far enough in advance.

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Retailers interested in selling the Sourcepak can receive a free dealer sales kit by writing to Source Telecomputing Corp., Communications Marketing Department, 1616 Anderson Rd., McLean, VA 22102.

Circle 550 on inquiry card.

Today for Videotex

Today magazine is for people and businesses in the personal computer and videotex industries. It examines how personal computers can be used to increase productivity, manage financial resources, communicate information, and educate. It provides news on the latest developments in videotex services and hardware, software, and communications technology. *Today* also probes the social and political issues of the industry.

Individual copies of *Today* magazine cost $2.50. It's published by Compuserve Inc., 5000 Arlington Centre Blvd., Columbus, OH 43220, (800) 848-8199; in Ohio, (614) 457-8650.

Circle 551 on inquiry card.

Daily News Hotline

The Information Intelligence Online Hotline is a daily news service for online readers in the information-retrieval field. Each issue is said to contain up-to-the-minute news concerning suppliers, vendors, producers, new and forthcoming databases, terminals, computers, modems, videodiscs, library and information networks, publications, and trends in the online field.

The Online Hotline can be accessed by 300- or 1200-bit-per-second Bell 103/212A-compatible terminals over ordinary telephone lines and many reduced-rate services. It's compatible with most terminals and microcomputers. X/On and X/Off protocol is supported. Subscriptions to the Hotline cost $100 per year, which includes unlimited access; there are no connect-time charges. For complete details, contact Information Intelligence Inc., POB 31098, Phoenix, AZ 85046, (602) 996-2283.

Circle 552 on inquiry card.

Trade Newspaper for Videotex Industry

Videotex Products is a quarterly newspaper for the videotex/teletext industry. This tabloid covers all items being developed for and sold on the worldwide videotex market. Its publisher, Worldwide Videotex, also produces the monthly **Worldwide Videotex Update**, available as an electronic edition on the Newsnet service.

For a free sample issue of the newspaper, write to Videotex Products, POB 138, Babson Park, Boston, MA 02157.

Circle 553 on inquiry card.

Delphi Accessible to Whole Family

General Videotex Corporation has introduced a national videotex system called Delphi. Delphi provides services and features for the entire family, including an online encyclopedia with up-to-the-minute entries; electronic banking and bill paying; searchable news, sports, and weather updates; shopping and travel information; games; online bulletin-board systems; and interactive community programs that allow users to converse. The Dialog Information Service database is also available through Delphi.

The Delphi videotex system is compatible with home computers that can be connected to telephone lines. Subscribers access information by means of simple steps rather than menus. Delphi adjusts its output to fit varying screen formats.

Future services will include a package designed for those with special needs, an expanded library of resource materials and educational tutorials, financial information, and an online interactive auction. A subscription to Delphi costs

$49.95. User-time fees are $0.85 for ten minutes (i.e., $5 per hour). Business rates are $20 per hour (8 a.m. to 6 p.m.). Complete details are available from General Videotex Corp., 377 Putnam Ave., Cambridge, MA 02139, (617) 491-3393.
Circle 554 on inquiry card.

RS-232C Telecomputing System

IXO Inc. has unveiled an RS-232C version of its hand-held telecommunications terminal, designed for local-network applications. The Model TC 103 is said to be suitable for hard-wire installation in a fixed location or for portable use where it can be connected directly to a computer system. Possible applications include field service and local access to electronic message systems within an office.

The TC 103 has a QWERTY-style keyboard with control and shift functions that generate the full 128-character set of ASCII codes. English-language dialogue keys that facilitate the development of computer-initiated dialogue software for operator training are provided. The TC 103 features a 16-character LCD (liquid-crystal display) that has such display-management functions as variable scroll rates ranging from 2 to 30 characters per second, automatic sound effects on grammatical constructions, and a repeat key that allows you to review the last 80 characters received.

In single units, the TC 103 costs $450. OEM (original equipment manufacturer) pricing as low as $250 per terminal is available. Corporate headquarters for IXO Inc. are located at 6041 Bristol Parkway, Culver City, CA 90230, (213) 417-8080.
Circle 555 on inquiry card.

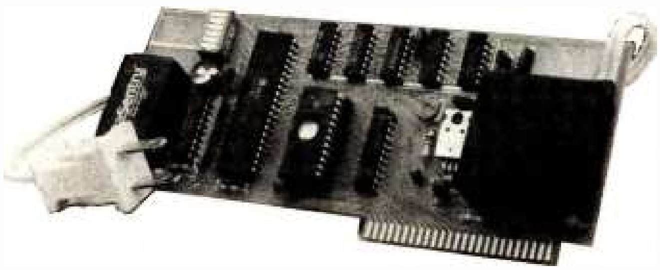
PERIPHERALS

Terminal Has 12 Programmable Keys

Visual Technology has extended the performance of its Visual 50 terminal with the introduction of the Visual 55. Among the enhancements built into this tilt-and-swivel terminal are 12 user-programmable nonvolatile function keys that can be dynamically allocated, extended editing with character insertion and deletion, selectable scrolling regions, and Visual 210 and Hazeltine 1510 emulation capabilities. Standard features include five attribute selections, a line-drawing character set, block mode, editing, a bidirectional auxiliary port, a 128-member uppercase and lowercase character set, columnar tabbing, and smooth or jump scrolling.

The nonglare screen's display format is 80 characters by 24 lines using a 7 by 9 dot-matrix grid, with a 25th status line. Menu-driven setup modes in nonvolatile memory are provided for easy selection of terminal parameters. The Visual 55 is code-for-code compatible with Hazeltine Espirit, Adds Viewpoint, Lear Siegler ADM 3A, and Digital Equipment Corporation VT-52.

The Visual 55 costs $895. Quantity discounts are available. For complete details, contact Visual Technology Inc., 540 Main St., Tewksbury, MA 01876, (617) 851-5000.
Circle 556 on inquiry card.



Energy Management Over Power Lines

Bi-Comm Systems' PC-1 combined with an Apple creates an efficient energy-management system. The PC-1 plugs directly into an Apple I/O slot and a standard wall socket. It communicates directly over power lines to operate as many as 256 Leviton/BSR remote-control units. With this arrangement, the Apple can control climate systems, appliances, lights, and other electrical devices for maximum energy efficiency. The 7- by 3-inch PC-1 is made up of a bidirectional carrier interface, a CMOS (complementary metal-oxide semiconductor) clock/calendar with battery backup, and a switch-selectable clock interrupt with rates of 1 hour, 1 minute, 1 second, and 1024 Hz. The battery backup offers 2 months of life and a full recharge capability in 16 hours.

The PC-1 comes with a demonstration disk that provides time scheduling, command console simulation, and utilities for initial power-up. A line-monitor program to detect power-line interference is provided. The PC-1 costs $265. Quantity discounts are available. Contact Bi-Comm Systems Inc., 10 Yorkton Industrial Court, St. Paul, MN 55117, (612) 481-0775.

Circle 557 on inquiry card.

Accessories for IBM

Compu-Quote offers a line of accessories for the IBM Personal Computer. Qwik-Key is a plastic overlay card that fits around the function keys so that you can mark each key's usage for a given program. A pack of three is available for $4.25. Quik-Guide consists of a pair of reference cards that contain all DOS commands. A set of two costs $3.25. Qwik-Label is a set of 18 self-adhesive labels that help you identify plug-in cards, knobs, and connectors on the front and rear panels of the IBM. Blanks for custom labels are included. A complete set costs $1.

Each item can be purchased separately or as part of a complete kit, which is $7.75. Contact Compu-Quote, 6914 Berquist Ave., Canoga Park, CA 91307, (213) 348-3662.

Circle 558 on inquiry card.

Processor Board with Diagnostics

The Z80 Smart Card, marketed by Forethought Products, is a combination processor and diagnostics unit for STD bus-based systems. This card has a 4-MHz Z80A processor with an onboard serial port, 2K bytes of RAM (random-access read/write memory), and diagnostic firmware. When connected to a standard RS-232C terminal, this card can test any board or I/O device in the STD system with its built-in diagnostic functions. Additional commands such as Display/Alter memory and Read/Write to an I/O device provide easy system debugging features. The Smart Card is equipped with a switch that lets it function as a standard Z80 processor card and performs a power-on jump to user PROM (programmable read-only memory). For easy system troubleshooting, you can instantly switch between Z80 and diagnostic modes.

The Z80 Smart Card costs $245 (quantity two to nine). Full specifications are available from Forethought Products, 87070 Dukhobar Rd., Eugene, OR 97402, (503) 485-8575.

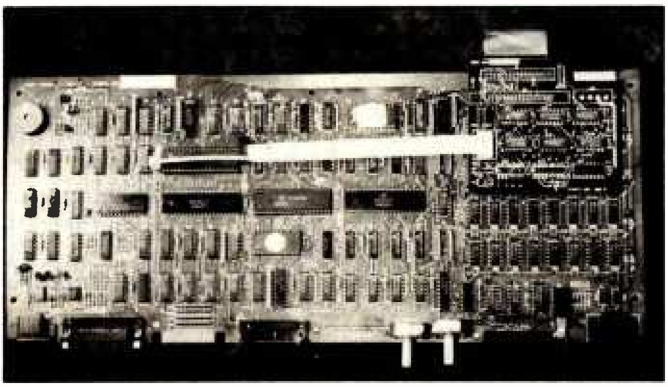
Circle 559 on inquiry card.

Speech Module for Sinclairs

The Parrot from Research In Speech Technology Inc. is a plug-in speech-synthesis module for Timex/Sinclair computers. Capable of generating the 64 discrete sounds (allophones) of spoken English, the Parrot comes with cassette-based software that lets you combine allophones so that you can string together words, phrases, sentences, and sound effects. You can also use your own programs to tell the Parrot what to say. It plugs directly into the ZX80/81 and the Timex/ Sinclair 1000 and is piggyback expandable so that other modules can be attached to the computer. An audio output jack for either a 4- or 8-ohm speaker and a volume control are provided.

The Parrot costs $89.95. It's available factory-direct from Research In Speech Technology Inc., POB 499, Fort Hamilton Station, Brooklyn, NY 11209, (212) 259-4934.

Circle 560 on inquiry card.



Osborne Expansion by Osmosis

Osmosis markets a line of Osborne 1 expansion equipment. The Osmos 1 is a digital plug-in board that offers 184K bytes of storage per disk. It costs $195 and can be installed at home or by a dealer in less than 30 minutes. The Osmos 2 kit has two double-sided drives that replace the existing drives. It provides up to 370K bytes of storage per disk and costs $895. For $1050, the Osmos 3 gives the Osborne 1.5 megabytes of storage on double-sided double-tracked drives.

Available free with the disk upgrades, Osmos 4 allows the Osborne to read, write, and format floppy disks from more than 20 different computers. Separately, it costs $225. The Osborne's screen format can be expanded from 52 to 80 columns with the Osmos 5, a $250 plug-in board.

Osmosis also markets Winchester disk drives, disk diagnostics, and analog-to-digital converters for the Osborne. For complete specifications, contact Osmosis, 430 Pacific Ave., San Francisco, CA 94133, (415) 864-6372.

Circle 561 on inquiry card.

SYSTEMS

TRS-80 Model 4 Unveiled

Radio Shack's TRS-80 Model 4 features an 80-column display, a 4-MHz Z80A microprocessor, and 64K bytes of memory, expandable to 128K bytes. This desktop computer is compatible with all existing Model III programs and with such operating systems as CP/M Plus, LDOS, and TRSDOS. Standard features include a job-control language, a print spooler, and a communications program. It comes with a 12-inch, high-resolution black-and-white monitor and a 70-key typewriter-style keyboard. The keyboard has a 12-key numeric pad, uppercase and lowercase characters, and three programmable function keys.

Radio Shack is developing new software for the Model 4 that will take advantage of its 80-column screen capabilities. These packages will include a spreadsheet calculator and a word processor. With two 184K-byte floppy-disk drives, an RS-232C serial interface, and a parallel printer interface, the Model 4 costs $1999. Further details are available at local Radio Shack stores and Computer Centers. Radio Shack, 1800 One Tandy Center, Fort Worth, TX 76102.

Circle 562 on inquiry card.

The Spirit of Victory

Victory Computer Systems' Spirit series of 16-bit small-business computers can be ordered with either Intel 80186 or Motorola MC68000 microprocessors. Operating system support is extended to CP/M-86, MP/M-86, CP/M-80, and Unix. The Spirit design employs VME bus architecture for peripheral expansion and up to 16 users. VME mixes 8-, 16-, and 32-bit microcomputers on a single system. Standard features include an advanced memory-management unit that allows addressing of up to 16 megabytes of memory, 256K bytes of dual-ported RAM (random-access read/write memory), seven high-speed serial RS-232C ports, an RS-422A port, and a Centronics-type parallel port. The Spirit uses a Zilog Z80 processor for distributed computing and intelligent I/O control and a 16-bit Zilog Z8002 chip for Winchester hard-disk control. The basic Spirit comes with a 5¼-inch removable-cartridge Winchester unit, a single 5¼- or 8-inch floppy-disk drive, and a fixed Winchester hard disk.

Memory options include 5¼- and 8-inch Winchester disks with up to 120 megabytes of storage, 5¼-inch removable disks with a 6-megabyte capacity, and slimline 5¼- and 8-inch floppy-disk drives. System prices range from $16,000 to $26,000, depending on configuration. For complete specifications, contact Victory Computer Systems, 201 East Hamilton Ave., Campbell, CA 95008, (408) 379-6200.

Circle 563 on inquiry card.

Low-Cost Computer for Novices

The VZ100 is an expandable system designed for the beginning computer user. This unit comes with 3K bytes of RAM (random-access read/write memory), built-in BASIC, and a full-size keyboard. The VZ100 can use any cassette-tape recorder for mass storage. Complete step-by-step instructions are provided.

Expansion equipment includes 16K- and 64K-byte memories, joysticks, a printer, light pen, modem, disk drives, bar-code reader, display monitor, and a full complement of software. The VZ100 costs less than $100. For full details, contact

Video Technology (U.S.) Inc., 2633 Greenleaf Ave., Elk Grove Village, Il 60007, (312) 640-1776.
Circle 564 on inquiry card.

Low-Cost Modular Computer

A Z80-based personal computer with a base price of $299.95, the Spectravideo offers such standard features as Microsoft's extended BASIC interpreter, CP/M 2.2 and CP/M Plus compatibility, 32K bytes of ROM (read-only memory), and 32K bytes of RAM (random-access read/write memory). Its input/output specifications include composite-video and audio output for a built-in TV modulator and a data-cassette interface. The display mode gives a 32-character by 24-line output using a 5- by 9-dot matrix and 16 keyboard-addressable colors. Each row of the display can be produced in different foreground and background colors. The SV-318's audio output capability provides three channels, each with an 8-octave range. The ASCII keyboard has 71 uppercase and lowercase characters, 52 graphics symbols, and 10 user-definable function keys. The keyboard console also houses a built-in joystick and a separate game cartridge slot. Editing abilities such as cursor-control and insertion/deletion keys are provided.

More than 100 software packages, including a word processor, an electronic spreadsheet, and arcade-type video games, support the SV-318. A data-cassette drive, a floppy-disk drive unit, and a dot-matrix printer are among the 15 hardware accessories currently available. A complete SV-318 can be ordered for less than $1500. For full particulars, contact Spectravideo, 39 West 37th St., New York, NY 10018, (212) 869-7911.
Circle 565 on inquiry card.

Bundle of Software Follows the Pied Piper

The Pied Piper I portable computer comes with four CP/M software programs: a word processor, an electronic spreadsheet, a 50,000-word dictionary, and a database filer. The 12½-pound Pied Piper is built around the 4-MHz Z80A processor and offers 64K bytes of RAM (random-access read/write memory), 1 megabyte of 5¼-inch floppy-disk storage, and an 80-character by 24-line video-display format. In addition, a full ASCII keyboard, a built-in Centronics-type parallel printer interface, and a video-monitor port are provided. The Pied Piper is supplied with a complement of communications utilities and the CP/M operating system.

Optional software for the Pied Piper includes dBASE II, Wordstar/Mailmerge, Supercalc, and MBASIC. It costs $1299. The Pied Piper is manufactured by STM Electronics Corp., Suite 130, 525 East Middlefield Rd., Menlo Park, CA 94025, (415) 326-6226.
Circle 566 on inquiry card.

Dual Drives Standard with SKS

Dual 560K-byte floppy-disk drives come as standard equipment with the SKS 2000 personal computer, a modular machine running the 4-MHz Z80A processor. It comes with 64K bytes of RAM (random-access read/write memory), a built-in monitor and keyboard controller, an RS-232C serial printer port, and the CP/M operating system. Its standard typewriter-style detachable keyboard has 13 word-processing keys, 5 cursor-control keys, 13 numeric keys, 8 function keys, and N-key rollover. The 12-inch P-31 green-phosphor video monitor offers an 80 by 24 format in an 8- by 12-dot grid and such attributes as reverse video and magnified character. The serial interface features half-duplex operation and transmission speeds up to 19,200 bits per second. Standard software includes Wordstar and Mailmerge.

Winchester hard-disk drives, RS-422A interfaces, a magnetic card reader/encoder, and a real-time clock are available as options. The SKS 2000 costs $2995. A dual-processor model is priced at $3795. For complete details, contact SKS Computers Inc., 4091 Leap Rd., Hilliard, OH 43026, (614) 876-8668.

Circle 567 on inquiry card.

PUBLICATIONS

Software Market Newsletter

The Software Market **Letter** is the monthly organ of the National Association of Free-Lance Programmers (NAFLP). This newsletter provides software-marketing information and advice, including the types of software in demand, how and where to sell programs, and how to get free-lance programming contracts. A unique feature of each issue is a complete directory of software buyers which is continually updated. The directory offers such information as the kind of software a buyer seeks, fees offered, terms and conditions, and how and where to contact the buyer. Each newsletter also has tutorial articles that provide examples and tips on negotiating contracts and selling software directly.

Membership in the NAFLP is open to all free-lance programmers. Annual dues are $48, which includes a subscription to the **Software Market Letter**. For further details, contact NAFLP, POB 813P, Vienna, VA 22180.

Circle 568 on inquiry card

Peek Inside Disk Drives

Inside Personal Computer Disk Storage Systems is an easy-to-understand look at what's going on inside your personal computer's floppy- and hard-disk storage system. Complete with illustrations, this 32-page book provides a full introduction to disks, drives, controllers, and operating systems. It costs $5 and is available from Percom Data Corp., 11220 Pagemill Rd., Dallas, TX 75243.

Circle 569 on inquiry card

Publication About Sinclair/Timex

Sin-Time Review is a bimonthly journal for owners of Sinclair/Timex computers. This publication has hardware and software reviews, articles, and programs written by Sinclair/Timex users. Other features include a consumer buying guide, book reviews, classified ads, and an index of periodicals and books.

Annual subscriptions to **Sin-Time Review** cost $12 (six issues). The **Sin-Time Review Buyers Guide** is available for $4.95. A combined package costs $16. Address inquiries to Sin-Time Review, Subscription Department, POB 742163, Houston, TX 77274.

Circle 570 on inquiry card

New Magazine to Focus on Computers in Elementary Schools

A magazine devoted to helping elementary school teachers understand and use microcomputers in the classroom will be released in September. Scholastic Inc.'s **Teaching and Computers** will offer first-person accounts of how teachers are successfully using computers in their classsrooms, nontechnical information about computers and how they work, and teacher-developed lesson ideas for all content areas. Also featured will be reproducible student-activity pages, recommended software for instruction or classroom management, and fresh information about free materials, new books, research, and conferences.

Teaching and Computers will be produced eight times during the school year. Subscriptions cost $15.95; bulk subscriptions of five or more are $9.95 each. Contact Scholastic Inc., 730 Broadway, New York, NY 10003, (212) 505-3000.

Circle 571 on inquiry card

Developments in Computer Law Probed

The **Computer/Law Journal** recently published its third annual issue devoted to current developments in computer law. The first articles in this edition focus on trade secrets and patent protection for computer software, respectively. From there, the discussion shifts to the liability of architects and enginners in the computer age. The steps involved in the negotiation and procurement of major computer systems are then analyzed, and vendor fraud and litigation arising from negotiations and procurement are investigated. Contributing authors are Miles Gilburne, Ron Johnston, Nelson Moskowitz, Paul Mathew, Duncan Davidson, and Craig Walker.

This special issue of the **Computer/Law Journal** costs $18; outside North America, it's $19. Contact the Center for Computer/Law, POB 54308 T. A., Los Angeles, CA 90054.

Circle 572 on inquiry card

Unix/C Newsletter

Quarterly, multivendor news for users, owners, prospective owners, and manufacturers of Unix and C products is available through

World Unix & C. Produced by Southwater Corporation, World Unix & C reports on mainframe, minicomputer, and microcomputer news and developments, and new Unix and C products. It has interviews with users and marketing personnel, company profiles, book and product reviews, tutorials, and project notes. Unix-like systems are also covered.

Prepaid annual subscriptions to World Unix & C cost $12; invoiced subscriptions are $16. Contact World Unix & C, Southwater Corp., 30 Mowry St., POB 5314, Mount Carmel, CT 06518, (203) 288-0283.

Circle 573 on inquiry card.

SOFTWARE

Child's Game Stresses Strategy

In Search of the Most Amazing Thing is a combination adventure, strategy, and arcade-type game for children from Spinnaker Software. Placed in a fantasy world, children are challenged to use strategy and employ their learning skills to discover the location and identity of "the most amazing thing." Children must negotiate economic and monetary situations with aliens, buy supplies, read maps, trade and bargain, write music, draw, take and write notes, organize materials, and make decisions. This program features color, sound effects, animation, and graphics.

In Search of the Most Amazing Thing runs on Apple, Atari, Commodore 64, and IBM Personal Computers. It costs $39.95 and comes with Jim Morrow's novel **The Adventures of Smoke Bailey**. It's available from Spinnaker Software, 215 First St., Cambridge, MA 02142, (617) 868-4700.

Circle 574 on inquiry card.

Context MBA Available for HP 16

The Context MBA integrated management software program now runs on the Hewlett-Packard Series 200 Model 16 and the Model 36 microcomputers. A product of Context Management Systems, MBA offers spreadsheet, word processing, graphics, telecommunications, and database functions. When combined with the HP Series 200, MBA lets you handle five simultaneous functions with immediate feedback: spreadsheet modeling, memo writing, analytical and presentation graphics, telecommunications, and searching, sorting, organizing, and using information. Its windowing feature allows more than one MBA function to appear onscreen, and any changes are automatically incorporated in other portions of a program. MBA uses a work space with 95 columns and 999 rows, and each MBA cell can hold up to 8000 characters.

Hewlett-Packard provides direct customer support for the MBA package, including 90 days of free telephone consultation. The suggested list price is $795. Contact Hewlett-Packard dealers for complete details.

Circle 575 on inquiry card.

Error Handler for PC

Ultratrap, a parity error-handling utility program from Daystar Systems, can be ordered through IBM Personal Computer dealers. This program intercepts and circumvents the PC's normal parity handler and resets the parity error-detection circuitry. Such occurrences are reported on the video monitor, which gives you the opportunity to ignore the error, abort the program and return to DOS, or reboot the system by means of a "warm-boot" sequence. It uses 8K bytes of memory and can be configured from the keyboard. No patches to PC-DOS 1.10 are required.

Ultratrap comes with a dynamic-memory allocation utility and a disk emulator. This package costs $39.95. It's available as standard equipment with the purchase of the 512K-byte UltraRAM add-on memory board for the IBM, which sells for $895. For complete details, contact Daystar Systems Inc., Suite L, 10511 Church Rd., Dallas, TX 75238, (214) 341-8136.

Circle 576 on inquiry card.

Checker Eyes Misspelled Words

Western Software Development's Spellpack can check the spelling of up to 50,000 words in any UCSD p-System file. It ignores special characters inserted by a word processor and provides a means for developing and maintaining any number of auxiliary dictionaries, which can accommodate 450 to 1340 words (maximum), depending on your computer. Spellpack displays full lines of text that have an incorrectly spelled word, and it lets you print sections of the main dictionary containing any subset of characters. Properly spelled words to be substituted for misspellings can be directed to either the same text file in which the error was detected or to a new text file. Spellpack also supplies you with information on the number of lines and words processed.

Spellpack runs on the IBM Personal Computer (with or without an 8087 coprocessor) and the Sage II. It costs $125 and is available from Western Software Development, POB 953, Woodland Park, CO 80863.

Circle 577 on inquiry card.

Full-Function Relational Database

The Oracle Version 3 is a full-function relational database for 16-bit microcomputers, mainframes, and minicomputers. It has multiuser capabilities, automatic recovery from system failure, and in-batch and online environments involving databases as large as billions of characters of data. It's provided with a complete set of software-development tools that include an interactive application generator, a report writer, a word processing and documentation preparation system, and an integrated data dictionary. A unique feature of Oracle 3 is its ability to accept data downloaded from a mainframe database for analysis and reporting on a microcomputer.

Oracle Version 3 currently works on Motorola 68000-based systems running Unix. The suggested retail price ranges from $600 to $2000, depending on the number of users. Contact Oracle Corp., Suite 180, Building 3, 3000 Sand Hill Rd., Menlo Park, CA 94025, (415) 854-7350.

Circle 578 on inquiry card.

Integrated Management System

Metafile for the IBM Personal Computer creates a development and operational environment that includes integrated facilities for high-level programming, word processing, database management, report generation, modeling, forms data entry, communications, and mailing-list and spreadsheet creation. Metafile can be used as an interactive program with menus and help screens, or it can be programmed to generate sophisticated applications.

Among Metafile's data-preparation capabilities are onscreen wordwrap, global text search and replace, relational database abilities, and an integrated data dictionary. For data processing, it offers 20-digit decimal precision, data-file recovery, keyed record access, and built-in syntax-parsing facilities. Other features include ascending and descending sort keys, a printer-control language, multiple-level sorts using any item, and screen windowing and partitioning. Online documentation and reference information is provided.

Metafile requires a monochrome or color graphics display, PC-DOS 1.1, 64K bytes of memory, a single 320K-byte floppy-disk drive, and an additional disk drive. It supports both removable and fixed Winchester disks and such printers as IBM Epson, NEC 3550, Dataproducts M200, and Okidata 84. It costs $1995. A version of Metafile is available for the Vector Graphic Series 3. For complete details, contact Sensor-based Systems, Olmsted Federal Building, Chatfield, MN 55923, (507) 867-4440.

Circle 579 on inquiry card.

User-friendly Risk Simulator

The Risk Simulator from Actuarial Microcomputer Software uses a Monte Carlo method to estimate probability distributions associated with various risk-involving situations. This program has user-friendly input formats and high-resolution graphics to make it easier to use and understand. Possible applications include the estimation of automobile maintenance expenses and employer self-funding of health-care benefits.

The Risk Simulator runs on 48K-byte Apple IIs, with a printer optional. It costs $187.50 and is available from Actuarial Microcomputer Software, 3915A Valley Court, Winston-Salem, NC 27106, (919) 765-5588.

Circle 580 on inquiry card.

Text Management Program

The Superfile System 3 text-management program from FYI Inc. automatically reindexes up to 65,000 records per database. Each free-format variable-length record is easy to update and can have as many as 500 keyword descriptors (maximum 32,000 keywords per database). Superfile System 3 lets you cross-index and retrieve records by linking as many as 128 keywords with "and," "or," and "not." You can search up to 255 floppy or hard disks per database. It provides software prompts, and output to a printer, screen, disk file, or any combination of the three.

The Post Haste program comes with Superfile. It works with Superfile or Micropro's Mail Merge and gives you capabilities for formatting and printing envelopes and membership and directory listings. Post Haste sorts alphabetically or by zip code.

Superfile System 3 will run on Z80 systems with CP/M version 2 or IBM PC-DOS. Two floppy-disk drives or a hard disk is required. The suggested retail price is $295. Contact FYI Inc., POB 26481, Austin, TX 78755, (800) 531-5033; in Texas, (512) 346-0133.
Circle 581 on inquiry card.

Three Program Packs for Commodore 64

Computermat has introduced three programs for the Commodore 64 Color Computer: Arcade Pak, Game Pak, and Ed-U-Pak. Arcade Pak offers three high-resolution arcade-type games. The first, Alien Invasion, has 20 levels of play and can be enjoyed by 1 to 4 players. Head-on's race against time provides 9 difficulty levels. Target Command challenges you to protect your cities from attacks from space. Arcade Pak is available on floppy disk or cassette for $29.95 and $24.95, respectively.

Three games comprise the Game Pak: Dragon Chase, Flip-It, and Deflect. In Dragon Chase, you must race through a maze to escape the dragon that wants to broil you. Flip-It is a strategy game that can turn the tables on you. Deflect is a bumper car game. The Game Pak is available on cassette for $14.95.

The four Ed-U-Pak programs are supplied on cassette for $24.95. Ruler places you in charge of a country. Micro lets you make a million dollars running a computer manufacturing plant. Dungeon of Mathacos, an adventure game, has you searching for treasures and answering mathematics questions. Geography lets you match names and locations around the world. For more information, call or write Computermat, 2984 Daytona, POB 1664, Lake Havasu, AZ 86403, (602) 855-3357.
Circle 582 on inquiry card.

FOREIGN

Medical Simulation

You're the Doctor is a recreational/educational simulation of medical diagnosis and treatment from Simulations Software. This role-playing game lets you examine and treat patients suffering illnesses ranging from skin rashes to abdominal pains (seven different problems in all). You must diagnose and treat your patients so that you can advance from the intern level to the chief of staff. Player options include lab tests, physical examinations, anesthesia, and surgery. Color graphics and sound effects are featured.

You're the Doctor runs on 48K-byte Apple IIs with one disk drive and DOS 3.3. The suggested retail price is $17.95, which includes a tutorial on medical laboratory tests. Contact Simulations Software, POB 608, Station U, Toronto, Ontario, M8Z 5Y9, Canada.
Circle 583 on inquiry card

Ready-made Enclosures

Industrial Design Consultancy distributes a range of off-the-shelf enclosures for computer systems. These enclosures, manufactured by Data Packaging Ltd. County Westmeath, Ireland, include 12-, 14-, and 15-inch cathode-ray tube bezels, a disk-drive housing, high- and low-profile keyboards, and a 19-inch control module. All enclosures are said to be flexible enough for end users to create their own product identity, and internal provisions allow various hardware options. For details, contact Industrial Design Consultancy, The Green, Datchet, Slough, Berkshire SL3 9EH, England; tel: Slough (0753) 47610.
Circle 584 on inquiry card

CP/M File Mover

Elektrokonsult's CP/M-to-CP/M file-transfer utility program File Mover can transfer any type of CP/M file from one computer to another by means of a serial link. File Mover uses an error detection and correction protocol with check sums and automatic retries to ensure error-free file transfer. File Mover runs on 8080-, 8085-, and Z80-based machines and can be used with data rates up to 9600 bits per second.

File Mover is available in a variety of disk formats, including 8-inch single-sided single-density, Osborne, Rainbow, and hard- and soft-sectored Zenith formats. With documentation, it costs $59.95, plus $8 shipping and handling. For more information, contact Elektrokonsult, POB 846, N-3001, Drammen, Norway; tel: (03) 83 15 00.
Circle 585 on inquiry card

Jet News from Japan

Jet News has up-to-the-minute reports on Japanese products, technology, and markets. This trade newsletter covers the Japanese consumer, component, computer, office equipment, communication, control instrumentation, and industrial/medical markets. Stories are filed from Japan and augmented with pictures and vital statistics. A recent issue focused on the Japanese government's voluntary offer to limit the number of VCRs (video-cassette recorders) exported to European Common Market member nations and what this could mean to the ailing European VCR industry.

Annual subscriptions to **Jet News** are offered at a variety of international exchange rates, ranging from 1000 Yen to 10.24 Deutsche Marks. **Jet News** is produced 24 times a year by Benn Electronics Publications Ltd., POB 28, Luton LU1 2NT, England; tel: Luton (0582) 417438; Telex: BUSAID 826314.
Circle 586 on inquiry card

MISCELLANEOUS

Ergonomic Keyboard Rated for 100 Million Operations

Cherry Electrical Products markets a low-profile, capacitive keyboard that meets the ergonomic workstation standards to become effective in 1985. The new specifications call for a maximum keyboard height of 30 mm (millimeters) from the top of the workstation desk to the top of the home-row keys when the keyboard is mounted in its enclosure. The Cherry keyboard measures less than 18 mm from the top of its printed-circuit board to the home-row keycaps.

The Cherry keyboard module consists of five parts: keycap, snap-in housing, plunger, spring, and metalized Mylar pad. Life expectancy is 100 million operations.

The Cherry keyboard can be ordered with linear or pad tactile feel, both with a positive stop. Sculptured or stepped spherical keycaps are offered. A fully encoded 83-key unit costs $150. In volume quantities, the price is $0.65 per key position for a microprocessor-based serial output unit. Contact Cherry Electrical Products Corp., 3600 Sunset Ave., Waukegan, IL 60087, (312) 578-3500.
Circle 587 on inquiry card.

Mouse for IBM PC

Microsoft is marketing a mouse for more than 25 MS-DOS-based personal computers, including the IBM. The Microsoft mouse is equipped with two buttons for selecting commands from the screen. It does not require a specially prepared surface. The mouse is supplied with a disk containing tutorial, practice application, and a text-editor program with insertion and deletion features.

The Microsoft mouse is available in two versions: the one for the IBM Personal Computer includes a plug-in board that fits into any slot on the PC's motherboard; the second version is designed for any MS-DOS-based computer. This unit works with a standard RS-232C interface and all its required hardware is built in. The Microsoft mouse costs $195, including software. Contact Microsoft Corp., 10700 Northup Way, Bellevue, WA 98004, (206) 828-8080.
Circle 589 on inquiry card.

Continuous Computer Forms

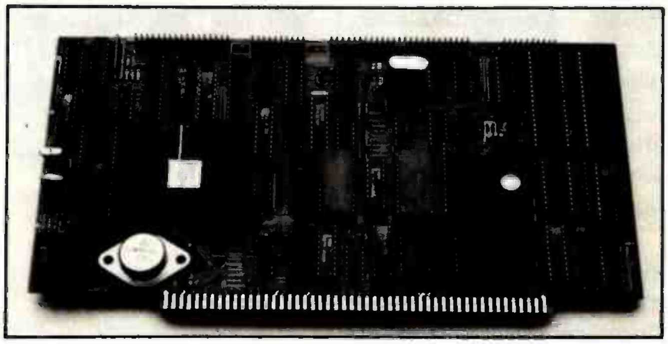
Micro Format, a mail-order company, offers a line of continuous computer forms, including letterhead with "clean edge" perforations on all four sides. Other products in the line include Rolodex cards, index cards, continuous envelopes, report papers, colored labels, post cards, and continuous checks.

A starter kit containing 500 blank letterheads, 500 labels, and 500 continuous 3- by 5-inch index cards is available for $24, postage paid. For a catalog, contact Micro Format, Suite 16 A, 1271 Dundee Rd., Buffalo Grove, IL 60090, (312) 537-2426.
Circle 590 on inquiry card.

Computer Access for Visually Impaired

The Viewscan Text System from Sensory Aids Corporation is an information-handling system for visually impaired individuals. With VTS, the sight-impaired can read printed text, type correspondence, store text on microcassettes, print out data, program computers, enter or read back data, and receive information from databases. System components include a personal computer using BASIC, a video screen capable of displaying characters 3 inches tall, a keyboard unit with a miniature printer, a handheld camera for scanning printed text, a calculator, clock/calendar, a full-size keyboard, and a communications interface. Each piece of the system can work independently.

A complete VTS system costs $5640, plus $40 shipping. The Viewscan display is $3500, and the computer is $2140. A tracking aid to guide a camera across reading material is available for $174, plus $10 shipping. For further information, contact Sensory Aids Corp., Suite 110, 205 West Grand Ave., Bensenville, IL 60106, (312) 766-3935.
Circle 591 on inquiry card.



Graphics-Display Controller

The iSBX 275 video-graphics controller is the latest addition to Intel's Multimodule line of circuit boards that plug into 8- or 16-bit Multibus buses. It's designed for OEM (original equipment manufacturer) applications such as process control, low-end workstations, and business presentation systems.

The iSBX 275 is a 3- by 7-inch device combining Intel's 82720 graphics-display controller with display memory. It can maintain and display data on a raster-scan screen and can connect to color or black-and-white monitors, with choice of 50- or 60-Hz frame rate. The iSBX 275 has approximately 32K bytes of onboard display memory that provides nominal resolution of 512 by 512 pixels for black-and-white screens or 256 by 256 pixels in eight colors. The 82720 controller lets you draw lines, circles, arcs, and rectangles with a single command and one or more parameters. It also handles such picture-manipulation operations as zoom and pan and can horizontally or vertically output preprogrammed 8 by 8 character fonts to the screen.

The iSBX 275 costs $995. OEM prices are available. Contact Intel Corp., Literature Department SV3-3, 3065 Bowers Ave., Santa Clara, CA 95051.

Circle 592 on inquiry card.

Twixtyper Upgrades Typewriters

An electronic typewriter can be upgraded to a word-processing system with Twixtyper. By means of a simple plug-in interface, Twixtyper provides up to 48K bytes of memory and a video monitor to the typewriter, which then functions as an I/O device. Interfaces are available for Adler, Royal, and Silver-Reed typewriters. For full particulars, contact Twix Inc., Suite 100, 10920 Switzer Ave., Dallas, TX 75238, (214) 349-0639.

Circle 593 on inquiry card.

S-100 Weighing System

Scalar Electronix has introduced a load-cell digitizing card for S-100 computers. This card provides weigh platforms, hoppers, tanks, and truck scales with a direct interface to an S-100 computer using strain-gauge transducers. Overall accuracy is 0.01%. Other features include a damping filter and selectable vectored interrupts that allow simultaneous operation of several cards, with each card having its own dead-load and span calibration settings. System hardware includes CMOS (complementary metal-oxide semiconductor) circuitry.

The S-100 weighing system card costs $495. For more information, contact Scalar Electronix Inc., POB 0863, Champlain, NY 12919, (514) 634-7026.

Circle 594 on inquiry card.

STD Bus Prototyping Board

Computer Dynamics' STD-WW1 prototyping wire-wrap board for the STD bus offers an interleaved power plane for +5-volt and ground power connections. Standard features include gold-plated edge card connectors, plated-through holes arranged for optimum DIP (dual inline package) placement patterns, and patterns arranged on the card for placement of header connectors.

In single units, the STD-WW1 costs $10. Contact Computer Dynamics Inc., 105 South Main St., Greer, SC 29651, (803) 877-7471.

Circle 595 on inquiry card.

Where Do New Products Items Come From?

The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgment the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. The information is printed more or less as a first-in first-out queue, subject to occasional priority modifications. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New?" feature is necessarily limited. We therefore cannot be responsible for product quality or company performance.

Circle 387 on inquiry card.

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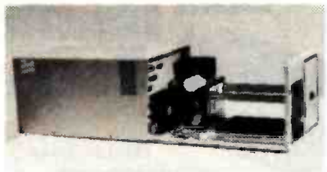
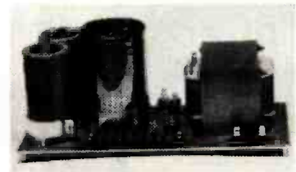
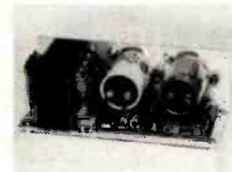
POWER SUPPLIES
(LINEAR & SWITCHING)
FOR S-100, DISK DRIVES



No. 806 & No. 516 Mainframes



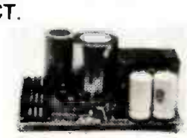
Kit 1, 2 & 3 for S-100



R_2, R_3 for 2 Drives (Floppy & Hard)

S-100 & DISK POWER SUPPLIES: OPEN FRAME, ASSY. & TESTED, 6 OUTPUTS, ADJU. & FUSES PROTECT.

ITEM		+5V OVP	−5V	+24V(OR +12V)	+8V	±16V	SIZE W x D x H	PRICE
S_3	12 SLOT & 2 FLOPPY (1 Floppy & 1 Hard Disk)	5A	1A	5-7A PEAK	13A	3A	10" x 6" x 5"	102.95
S_4	6 SLOT & 2 FLOPPY	4A	1A	4-5A PEAK	8A	3A	8⅜" x 5" x 4¾"	92.95



S_3, S_4 for S-100 & 2 Drives

DISK POWER SUPPLIES: OPEN FRAME, ASSY. & TESTED, REGULATED, ADJUSTABLE & FUSES PROTECT.

ITEM	IDEAL FOR	+5V OVP	−5V	+24V (or +12V)	+8V Unreg.	±12V	SIZE W x D x H	PRICE
R_0	2 x 8" SLIMLINE	2.5A		2.5A - 5A Peak			5" x 4" x 4"	**49.95**
R_1	2 x 8" or 2 x 5¼" DISK	4A	1A	3A - 5A Peak	2A		8" x 4" x 3¾"	**54.95**
R_2	3 x 8" (or 5¼") FLOPPY	6A	1A	6A - 8A Peak			10" x 4⅞" x 3¾"	**69.95**
R_3	or 1x Floppy & 1x Hard	6A	1A	6A - 8A Peak		1A	9" x 6¼" x 4⅜"	**81.95**

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ITEM	(IDEAL FOR)	+8V	−8V	+16V	−16V	+28V	SIZE: WxDxH	PRICE
KIT 1	15 CARDS	15A	---	2.5A	2.5A	---	12" x 5" x 4⅞"	**54.95**
KIT 2	20 CARDS	25A	---	3A	3A	---	12" x 5" x 4⅞"	**61.95**
KIT 3	DISK SYSTEM	15A	1A	3A	3A	5A	13½" x 5" x 4⅞"	**69.95**

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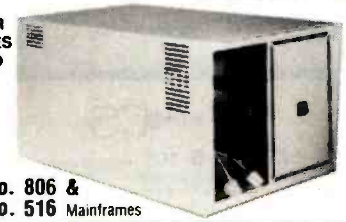
ITEM #516 FOR 2 EA. 5¼" FLOPPY (TANDON TM-100 – 1, 2, 3, 4 OR EQUIV.), OR ONE 5¼" FLOPPY & ONE 5¼" WINCHESTER HARD DISK (TANDON TM 600-2, 3 OR EQUIV.), POWER SUPPLY: +8V/8A, ±16V/3A OVP, +5V/6A OVP, +12V/6A, 8A PEAK. SIZE: 13.75"(W) x 19.5"(D) x 7"(H).



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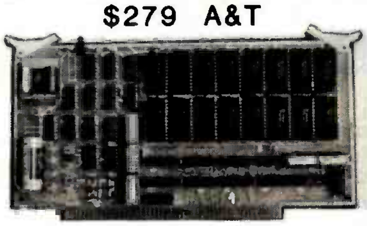

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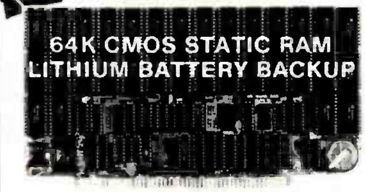

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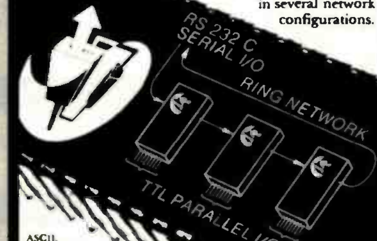

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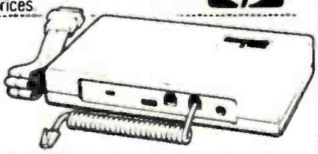

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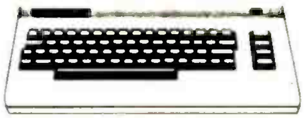

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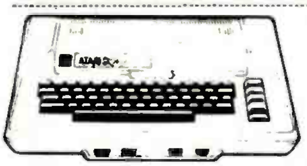

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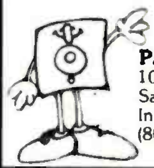

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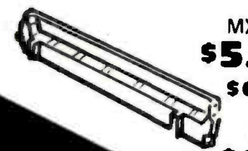

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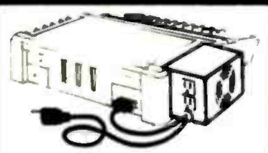

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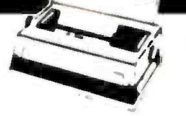

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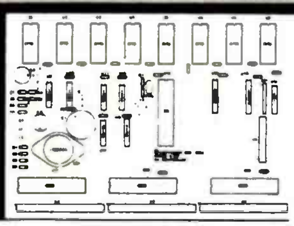

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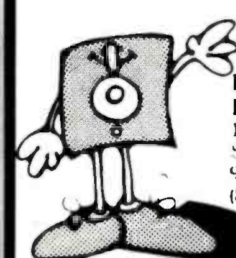

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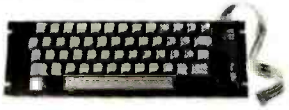

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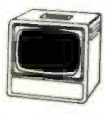

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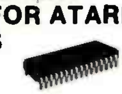

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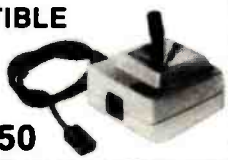

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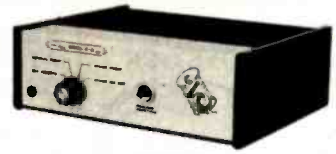

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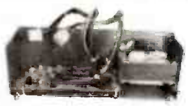

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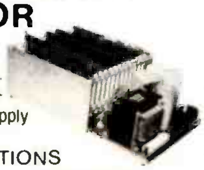

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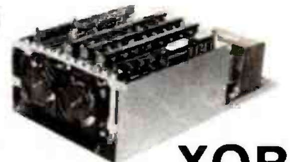

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DP8279	40	Prog. Keyboard/Display Interface	8.95
DP8303	20	8-Bit Tri-State Bi-Directional Trans.	3.95
DP8304	20	8-bit Bi-Directional Receiver	2.49
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DP8311	20	Octal Latched Peripheral Driver	4.95

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M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00
30003	1982 Nat. Linear Book (1952 pg.)	11.95
30008	1980 Nat. Memory Data Book (464 pg.)	6.95
30011	1980 Nat. Linear Applications (736 pg.)	15.95
30013	1983 Zilog Data Book (641 pg.)	7.95

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DS0025CN	8	Dual MOS Clock Driver (5MZ)	2.49
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4116N-3	16	16,384x1	(200ns)	1.69 - 8/12.95
4116N-4	16	16,384x1	(250ns)	1.49 - 8/10.95
4164N-150	16	65,536x1	(150ns)	7.95 - 8/59.95
4164N-200	16	65,536x1	(200ns)	7.49 - 8/54.95
MM5261	16	1024x1	(300ns)	.49 - 8/1.95
MM5282	22	2048x1	(365ns)	.49 — 8/1.95
MM5270	18	4096x1	(250ns) MK4096	4.95
MM5280	22	4096x1	(200ns) 2107	3.95
MM5290-2	16	16,384x1	(150ns)	1.89 8/14.95
MM5290-3	16	16,384x1	(200ns)	1.69 8/12.95
MM5290-4	16	16,384x1	(250ns)	1.49 8/10.95
MM5298-3	16	8192x1	(200ns)	1.69

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1101	16	256x1	(650ns)	1.49
2101	22	256x4	(450ns) 8101	2.49
2102	16	1024x1	(350ns)	.89
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2112	16	256x4	(450ns) MOS	2.95
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2114L-2	18	1024x4	(200ns) L.P.	2.49 - 8/17.95
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TMS4044	18	4096x1	(450ns)	3.95
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MM5257	18	4096x1	(450ns) 4044	3.95
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HM6116-4	24	2048x8	(200ns) CMOS	6.95
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AY-5-1013A	40	30K Baud Uart (TR1602)	4.95

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The DT1050 consists of a Speech Processor Chip, MM54104 (40-pin) and two (2) Speech ROMs MM52164SSR1 and MM52164SSR2 (24-pin) along with a Master Word list and a recommended schematic diagram on the application sheet.

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74HC76	16	.75	74HC193	16	1.39	74HC4060	16	2.19
74HC85	16	2.19	74HC194	16	1.59	74HC4075	14	.75
74HC86	14	.99	74HC195	16	1.49	74HC4078	14	.69
74HC107	14	.75	74HC242	14	2.79	74HC4511	16	3.29
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74C10	14	.35	74C157	16	2.25	74C374	20	2.49
74C14	14	.59	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
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74C48	16	1.95	74C173	16	.79	74C915	18	1.19
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74C89	16	5.95	74C195	16	1.39	74C926	18	5.95
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TL072CP	8	1.39	LM340T-12		.79	LM710N	14	.69
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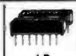
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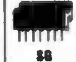
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16 pin ST	.34	.32	.30
18 pin ST	.38	.36	.34
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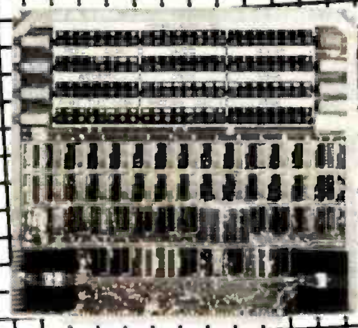

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64K STATIC RAM - Jade

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*	$99.95
MEM-32152K	*32 kit*	$199.95
MEM-56152K	*56K kit*	$289.95
MEM-64152K	*64K kit*	$299.95
Assembled & Tested		add $50.00

EXPANDORAM III

SD Systems new 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*	$495.00
MEM-65128A	*128K*	$595.00
MEM-65192A	*192K*	$675.00
MEM-65256A	*256K*	$755.00

LETTER QUALITY PRINTERS

Letter Quality Printer - BMC

Wordstar compatible, Diablo protocals, proportional and incremental spacing, 16 CPS bi-directional printing, 10, 12 or 15 CPI, up to 17-inch wide paper. Available in parallel or serial versions.

PRD-52001	*Parallel*	$799.00
PRD-52002	*Serial*	$829.00
PRA-52000	*Tractor option*	$159.95

380Z by D.T.C.

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 include 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.

PRD-11300	*380Z printer*	$1295.00
PRA-11000	*Tractor option*	$169.95
PRA-1200	*Cut sheet feeder*	$699.95
Cable	*Please specify*	$49.95

Printers From Jade

SEIKOSHA	*10" Graphics, 30 CPS*	$229.95
OKIDATA 82	*10" 120 CPS*	CALL
OKIDATA 92	*10" 160 CPS with Graphics*	CALL
OKIDATA 93	*15" 160 CPS with Graphics*	CALL
OKIDATA 83	*15" 120 CPS with Tractor*	CALL
OKIDATA 84	*15" 200 CPS with Graphics*	CALL
OKIDATA 2350	*15" 350 CPS*	CALL
OKIDATA 2410	*15" 350 CPS, Two color*	CALL
DAISYWRITER 2000	*48K Daisywheel*	$1395.00
GEMINI 10	*100 CPS 10" with Graphics*	$349.95
GEMINI 15	*100 CPS 15" with Graphics*	$499.95
COMREX CR1		$849.95

PRINTER PALS — FMJ

Desk top printer stand and paper rack. Fits all printers.

PRA-99080	*10" Printer pal*	$29.95
PRA-99100	*15" Printer pal*	$39.95
PRA-99700	*for Letter Quality*	$49.95

S-100 I/O BOARDS

The BUS PROBE — Jade

Inexpensive S-100 Diagnostic Analyzer

TSX-200B	*Bare board*	$59.95
TSX-200K	*Kit*	$129.95
TSX-200A	*A & T*	$159.95

I/O-4 — SSM Microcomputer

2 serial I/O ports plus 2 parallel I/O ports

IOI-1010A	*A & T*	$249.95

I/O-5 — SSM Microcomputer

Two serial & 3 parallel ports, 110-19.2K Baud

IOI-1015A	*A & T*	$289.95

INTERFACER 4 — CompuPro

3 serial, 1 parallel, 1 Centronics parallel

IOI-1840A	*A & T*	$389.95
IOI-1830C	*CSC*	$495.00

S-100 EPROM BOARDS

PB-1 — SSM Microcomputer

2708, 2716 EPROM board with on-board programmer

MEM-99510K	*Kit with manual*	$154.95
MEM-99510A	*A & T with manual*	$219.95

PROM-100 — SD Systems

2708,2716, 2732 EPROM programmer with software

MEM-99520K	*Kit with software*	$189.95
MEM-99520A	*A & T with software*	$249.95

VIDEO MONITORS

VIDEO MONITOR — Jade

1000 lines ultra-high resolution, 20 MHz ultra-high band width, 9" or 12", Amber or Green phosphor, the finest monitors we sell.

VDM-740920	*9" Green*	$99.95
VDM-740910	*9" Amber*	$129.95
VDM-751220	*12" Green*	$129.95
VDM-751210	*12" Amber*	$139.95

12" GREEN SCREEN — Zenith

15MHz, 40 or 80 column

VDM-201201	*12" Green*	$114.95

DUAL DISK SUB-SYSTEMS

DISK Sub-Systems — Jade

Handsome metal cabinet with proportionally balanced air flow system, rugged dual drive power supply power cable kit, power switch, line cord, fuse holder, cooling fan, nevermar rubber feet, all necessary hardware to mount 2-8" 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 — Single Sided, Double Density

END-000423	*Kit w/2 Siemens FD100-8Ds*	$650.00
END-000424	*A & T w/2 Siemens FD100-8Ds*	$695.00
END-000433	*Kit w/2 Shugart SA-801Rs*	$999.95
END-000434	*A & T w/2 Shugart SA-801Rs*	$1195.00

8" Sub-Systems — Double Sided, Double Density

END-000426	*Kit w/2 Qume DT-8s*	$1224.95
END-000427	*A & T w/2 Qume D-8s*	$1424.95
END-000436	*Kit w 2 Shugart SA-851Rs*	$1274.95
END-000434	*A & T w/2 Shugart SA-801Rs*	$1195.00

S-100 MOTHERBOARDS

ISO-BUS - Jade

Silent, simple and on sale — a better motherboard

6 Slot (5¼" x 8⅝")

MBS-061B	*Bare board*	$22.95
MBS-061K	*Kit*	$39.95
MBS-061A	*A & T*	$69.95

12 Slot (9¾" x 8⅝")

MBS-121B	*Bare board*	$34.95
MBS-121K	*Kit*	$69.95
MBS-121A	*A & T*	$109.95

18 Slot (14½" x 8⅝")

MBS-181B	*Bare board*	$54.95
MBS-181K	*Kit*	$99.95
MBS-181A	*A & T*	$149.95

S-100 CPU BOARDS

The BIG Z — Jade

2 or 4 MHz switachable Z-80 CPU board with serial I/O accommodates 2708, 2716, or 2732 EPROM, baud rates from 75 to 9600.

CPU-30201B	*Bare board w/manual*	$35.00
CPU-30201K	*Kit with Manual*	$149.95
CPU-30201A	*A & T with Manual*	$199.95

SBC-200 - SD Systems

4 MHz Z-80A CPU with serial & parallel I/O, 1K RAM, 8K ROM space, monitor PROM included.

CPU-30200A	*A & T*	$329.95

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 & 16 bit CPUs, standard 8 bit S-100 bus, up to 8 MHz, accesses 16 Megabytes of memory

CPU-20510A	*6 MHz A T*	$429.95
CPU-20510C	*6/8 MHz CSC*	$529.95

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800-262-1710

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213-973-7707

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**

5 1/4" DISK DRIVES

Tandon TM100-1 single-sided double-density 48 TPI
MSM-551001 $219.95 ea 2 for $199.95 ea

Shugart SA400L single-sided double-density 40 track
MSM-104000 $234.95 ea 2 for $224.95 ea

Tandon TM100-2 double-sided double-density 48 TPI
MSM-551002 $294.95 ea 2 for $269.95

MPI B52 double sided, double density, 48 TPI can be substituted for CDC.
MSM-155200 $299.95 ea 2 for $279.00 ea

MPI B51 single sided, double density 48 TPI
MSM-155100 $239.95 ea 2 for $199.95 ea

5¼" Cabinets With Power Supply

END-000216 *Single cab w/power supply* $69.95
END-000226 *Dual cab w/power supply* $94.95

8" SLIMLINE SUB-SYSTEMS

Dual Slimline Sub-Systems — 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 2-8" slimline disk drives. Does not include signal cable.

Dual 8" Slimline Cabinet
END-000820 *Bare cabinet* $59.95
END-000822 *A & T w/o drives* $179.95

Dual 8" Slimline Sub-Systems
END-000823 *Kit w/2 SS DD Drives* $919.95
END-000824 *A & T w/2 SS DD Drives* $949.95
END-000833 *Kit w/2 DS DD Drives* $1149.95
END-000834 *A & T w/2 DS DD Drives* $1179.95

8" DISK DRIVES

Siemens FDD 100-8 single-sided double-density
MSF-201120 $274.95 ea 2 for $249.95 ea

Shugart SA801R single-sided double-density
MSF-10801R $394.95 ea 2 for $389.95 ea

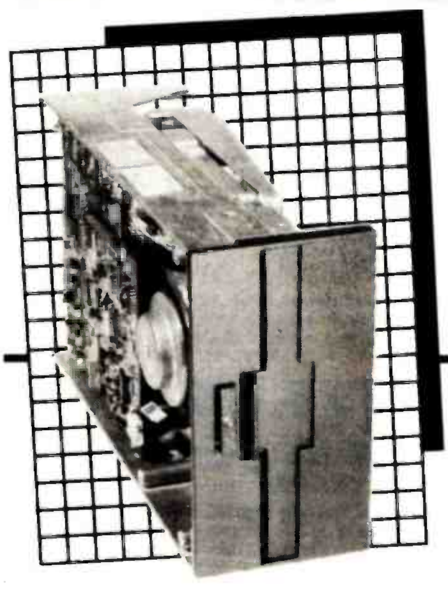
Shugart SA851R double-sided double density
MSF-10851R $554.95 ea 2 for $529.95 ea

Qume DT-8 double-sided double-density
MSF-750080 $524.95 ea 2 for $498.95 ea

Tandon TM8481 single-sided double-den thin-line
MSF-558481 $379.96 ea 2 for $369.95 ea

Tandon TM848-2 double-sided double-den thin-line
MSF-558482 $494.95 ea 2 for $484.95

NEC FD1165 double-sided double-den thin-line
MSF-851165 $484.95 ea 2 for $449.95



MODEMS

Smart Buy in MODEMS — Signalman

1200 and/or 300 baud, direct connect, automatic answer or originate selection, auto-answer/auto-dial on deluxe models. 9v battery allows total portability, full one year warranty.

IOM-5600A *300 baud direct connect* $89.95
IOM-5610A *300 baud Deluxe* $149.95
IOM-5620A *1200/300 baud Deluxe* $369.95
IOM-5650A *300 baud for Osborne* $119.95
IOM-5630A *300 baud card for IBM* $269.95
IOM-5690A *1200 baud option for IBM* $129.95

SMARTMODEM — Hayes

Sophisticated direct-connect auto-answer/auto-dial modem, touch-tone or pulse dialing, RS-232C interface programmable

IOM-5500A *Smartmodem 1200* $574.95
IOM-5400A *Smartmodem 300* $224.95
IOK-1500A *Hayes Chronograph* $218.95
IOM-1100A *Micromodem 100* $368.95
IOM-2010A *Micromodem II w/Term prgm* $329.95
IOM-2012A *Terminal program for MMII* $89.95

1200 BAUD SMART CAT — Novation

103/212 Smart Cat & 103 Smart Cat, 1200 & 300 baud, built-in dialer, auto re-dial if busy, auto answer/disconnect, direct connect, LCD 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* $149.95

S-100 DISK CONTROLLERS

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* $359.95
SFC-55009047F *CP/M 3.0 With VF-II* $139.95

2422 DISK CONTROLLER — C.C.S.

5¼" or 8" double density disk controller with on-board boot loader ROM, free CP/M 2.2 & manual set

IOD-1300A *A & T with CP/M 2.2* $399.95

DOUBLE D — Jade

High reliability double density disk controller with on-board Z-80A, auxiliary 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

DISK TUBS

DISKETTE STORAGE BOXES

Clear Plexiglass storage boxes for up to 75 Diskettes

MMA-505 *Holds 75 5¼"* $19.95
MMA-508 *Holds 50 8"* $24.95

EPROM ERASERS

ULTRA-VIOLET EPROM ERASERS

Inexpensive erasers for industry or home.

XME-3100A *Spectronics w/o timer* $69.50
XME-3101A *Spectronics with timer* $94.95
XME-3200A *Logical Devices* $49.95

APPLE II ACCESSORIES

SUPER DISKETTE SPECIAL!

We bought out a major manufacturer's overstock, and we are passing the savings on to you! Single sided, double density, package of 10 in plastic library case.

MMD-5121003 *Apple Diskettes* $18.95
$16.95

DISK DRIVE - Fourth Dimension

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 *Forth Dimension drive* $249.95
MSM-431030 *Controller only* $60.00
MSM-431040 *Controller with software* $99.95

HALF—HEIGHT DRIVE - Laser Micro.

Totally Apple Compatible. Works with all Apple software and controllers. Faster and quieter than most other drives, yet only half the size!

MSM-571010 *Laser half-height* $299.95

CP/M 3.0 CARD for Apple — A.L.S.

The most powerful card available for your Apple!

6MHz Z-80B, additional 64K of RAM, CP/M 3.0 plus 100% CP/M 2.2 compatibility, C basic, CP/M Graphics, 300% faster than any other CP/M for Apple. One year warranty.

CPX-62810A *A.L.S. CP/M Card* $349.95

Z-CARD for Apple II — A.L.S.

Two computers in one, Z-80 & 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.

CPX-62800A *A & T with CP/M 2.2* $159.95

80 COLUMN APPLE CARD

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 & Fortran compatible, 50/60 Hz, 40/80 column selection from keyboard. Best 80 column card!

IOV-2450A *Viewmax 80* $149.95
IOV-2455A *Preboot disk for above* $29.95

16K RAM Card — for Apple II

Expand your Apple II 64K, use as language card, full 1 year warranty. Why spend $175.00?

MEX-16700A *Save over $115.00* $49.95

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* $139.95

JADE

Computer Products

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NOT JUST AN ORDINARY SALE! WE HAVE **SLASHED PRICES TO THE BONE** AS OUR WAY OF THANKING YOU, OUR VALUED CUSTOMERS FOR 6 YEARS OF LOYALTY. WE'VE CONTINUOUSLY GROWN AND EXPANDED BY OFFERING YOU THE BEST VALUE FOR YOUR MONEY WITH THE BEST AFTER-SALE SUPPORT

AT LAST! CP/M® 68K®!!!

CompuPro®

CPU BOARDS

68K - 68000 16 BIT CPU

16 bit 8 or 10 MHz on-board sockets for 2716 2732 or 2764 EPROMs for up to 8K x 16 of memory

Part No.	Description	List Price	Our Price
BSGBT184A	A&T 8MHz	$695.00	$518.95
BSGBT184C	CSC 10MHz	$850.00	$765.00

CP/M® 68K NOW AVAILABLE!!

Now CompuPro and Digital Research bring you CP/M for the 68000®

BSGBTCPM68K	68000 CP/M®		$350.00

FORTH OPERATING SYSTEM FOR 68K CPU

Requires a DISK 1 64K of CompuPro memory, and an INTERFACER 3 or 4

BSGBT68KOS	FORTH operating system		$200.00

CO-PROCESSOR 8086/8087

16 bit 8 or 10 MHz 8086 CPU with sockets for 8087 and 80136

BSGBT186A	A&T 8MHz 8086 only	$ 750.00	$494.95
BSGBT186C	CSC 10MHz 8086 only	$ 850.00	$764.89
BSGBT186A87	A&T with 8087 option	$1050.00	$939.00
BSGBT186C87	CSC with 8087 option*	$1150.00	$1065.00

*8087 Limits clock speed to 5MHz

DUAL PROCESSOR 8085-8088

6 or 8 MHz provides true 16 Bit Power with a standard 8 bit S-100 bus

BSGBT1812A	A&T 6MHz	$495.00	$318.97
BSGBT1812C	CSC 6/8 MHz	$595.00	$497.87

CPUZ - Z80B CPU NOW 6MHz!

3/6 MHz Z80B CPU with 24 Bit Addressing.
FASTEST Z80 CPU AVAILABLE!

BSGBT160A	3/6 MHz A&T	$325.00	$228.95
BSGBT160C	3/6 MHz CSC	$425.00	$374.87

DISK CONTROLLERS

DISK 1 DMA FLOPPY CONTROLLER

Fast DMA, Soft Sector, Controls Up to Four 8" or 5¼" Single or Double Density Drives!

BSPDB171ACPM	A&T w/CPM 2.2® & BIOS	$670.00	$489.00
	When purchased w/two 8" disk drives only		$450.00
BSGBT171CCPM	CSC w/CP/M 2.2® & BIOS	$770.00	$595.00
BSGBT171A	Disk 1 Controller A&T	$495.00	$368.95
BSGBT171C	Disk 1 Controller CSC	$595.00	$550.00
BSGBTCPM80	CP/M 2.2® for Z80/8085 w/manual & BIOS 8" S/D disk		$148.95
BSGBTCPM86	CP/M 2.2® for 8086 w/manuals & BIOS 8" S/D disk		$258.95

DISK 2/SELECTOR CHANNEL HARD DISK CONTROLLER

Fast DMA 2 board set controls 4 Shugart 4000 series or Fujitsu 2300 type drives. Includes CP/M 2.2®.

BSGBT177A	Assembled & Tested	$795.00	$568.95
BSGBT177C	CSC	$895.00	$850.00

M-DRIVE/H HARDWARE LOGICAL DISK SYSTEM

Interfaces through two I/O ports, and runs at 10MHz IEEE 696 compatible. Requires any CompuPro CPU and a DISK 1. Each board contains 512K of fast, low power (900mA) RAM, with parity checking.

BSGBT197A	M-DRIVE/H w/software, A&T	$1895.00	$1295.00
BSGBT197C	M-DRIVE/H w/software, CSC	$2095.00	$1495.00

STATIC RAM

RAM 17 - 64K CMOS STATIC RAM

12 MHz, RAM 17, 2 Watt, DMA Compatible 24 Bit Addressing

BSGBT175A64	64K A&T 12MHz	$499.00	$480.00
BSGBT175C64	64K CSC 12MHz	$599.00	$550.00

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

BSGBT180A	64K A&T 12MHz	$550.00	$510.00
BSGBT180C	64K CSC 12MHz	$650.00	$610.00

RAM 21 - 128K STATIC RAM

816 RAM 21 12MHz, 128K x 8 or 64K x 16 IEEE/696
(816) 8 or 16 Bit, 1.2 Amps, 24 Bit Addressing

BSGBT190A	128K A&T	$1095.00	$995.00
BSGBT190C	128K CSC	$1245.00	$1125.00

CompuPro®

I/O BOARDS

SYSTEM SUPPORT 1 MULTIFUNCTION BOARD

Serila port (software prog. baud), 4K RAM included, 15 levels of interrupt, real time clock, optional math processor.

Part No.	Description	List Price	Our Price
BSGBT162A	Assembled & Tested	$450.00	$308.95
BSGBT162C	CSC	$550.00	$495.00
BSGBT8231	Math Chip		$195.00
BSGBT8232	Math Chip		$195.00
BSGBT162AM1	A&T w/8231 Math Chip	$645.00	$538.95
BSGBT162CM1	CSC w/8231 Math Chip	$745.00	$670.00
BSGBT162AM2	A&T w/8232 Math Chip	$645.00	$538.95
BSGBT162CM2	CSC w/8232 Math Chip	$745.00	$670.89

MPX CHANNEL BOARDS

I/O Multiplexer, using 8085A-2 CPU on board w/16K RAM

BSGBT166A16	Assembled & Tested	$649.00	$584.89
BSGBT166C16	CSC	$749.00	$674.89

INTERFACER 1

Two Serial I/O

BSGBT133A	Assembled & Tested	$295.00	$198.95
BSGBT133C	CSC	$370.00	$329.00

INTERFACER 2

Three parallel, one serial I/O board

BSGBT150A	Assembled & Tested	$325.00	$249.00
BSGBT150C	CSC	$399.00	$359.00

INTERFACER 3

Eight-channel multi-user serial I/O board

BSGBT1748A	Assembled & Tested	$699.00	$448.95
BSGBT1748C	CSC 200 hr. 8 port	$849.00	$748.89
BSGBT1745A	Assembled & TEsted	$599.00	$518.95
BSGBT1745C	CSC 200 hr. 5 port	$699.00	$628.89

INTERFACER 4

Three Serial, 1 Parallel, 1 Centronics Parallel

BSGBT187A	Assembled & Tested	$450.00	$314.87
BSGBT187C	CSC	$540.00	$414.87

S-100 MOTHERBOARDS

Active Termination, 6-12-20 Slot

BSGBT153A	A&T 6 slot (2 lbs.)	$140.00	$125.00
BSGBT153C	CSC 6 slot (2 lbs.)	$190.00	$155.00
BSGBT154A	A&T 12 slot (3 lbs.)	$175.00	$155.00
BSGBT154C	CSC 12 slot (3 lbs.)	$240.00	$220.00
BSGBT155A	A&T 20 slot (4 lbs.)	$265.00	$235.00
BSGBT155C	CSC 20 slot (4 lbs.)	$340.00	$310.00

California Computer Systems

Z80 CPU 2 or 4MHz

On board RS232 Serial port, On board 2K Monitor, ROM, Power on jump to any location in 64K, LED status indicators for ROM select, halfstate and interrupts.

BSCCS2810A	Z80A 4MHz CPU A&T	$325.00	$258.95

CCS271901

BSCCS271901	2 Serial, 2 Parallel, A&T	$360.00	$288.95

CCS27201

BSCCS272001	4 Port Parallel, A&T	$275.00	$218.95

CCS271001

BSCCS271001	4 Port Serial, A&T	$325.00	$278.95

CCS2830

BSCCS283001	Assembled & Tested	$550.00	$428.95

CCS206601

64K Dynamic S-100 RAM, Cromemco CROMIX™ Compatible

BSCCS206601	Assembled & Tested	$450.00	$425.00

CCS2422A

Floppy disk controller w/CP/M 2.2®

BSCCS2422A	Assembled & Tested	$475.00	$338.95

SSM

IO5

2 Serial, 3 Parallel S-100 Interface

Part No.	Description	List Price	Our Price
BSSSMIO5A	Assembled & Tested	$329.00	$289.95

IO8

8 Port Serial I/O S-100 Board

BSSSMIO8A	Assembled & Tested	$550.00	$450.00

IO4

2 Serial, 2 Parallel I/O S-100 Board

BSSSMIO4A	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)

BSSSMB8A	Assembled & Tested	$265.00	$219.87

DUAL

NON VOLATILE CMOS RAMS

8, 16; or 32K, 8 or 16 Bit Data, Battery Backup On Board 6MHz, Bank Selectable

BSDULCMEM8	8K A&T	$495.00	$450.00
BSDULCMEM16	16K A&T	$595.00	$550.00
BSDULCMEM32	32K A&T	$695.00	$650.00

256K DYNAMIC MEMORY

256K, 230 ns access time, 2 x 128K organization, 24 bit addressing, parity error detection

BSDULDMEM256K	Assembled & Tested	$1295.00	$1195.00

32/64K EPROM BOARD

8 or 16 bit data, holds 2716s (32K), or 2732s (64K)

BSDULEPROM32	For 2716s A&T	$295.00	$275.00
BSDULEPROM64	For 2732s A&T	$295.00	$275.00

A/D CONVERTER

12 Bit Resolution 16 or 32 Channel Input

BSDULAIM12	Assembled & Tested	$695.00	$625.00
BSDULAIM12B	Without instru. Amp	$645.00	$598.00

D/A CONVERTER

4 Channel, 12 Bit, 3 Output Modes

BSDULAOM12	Assembled & Tested	$695.00	$618.95

SIERRA DATA SCIENCES

S-100 SBC BOARD

Z80A 4MHz, 2 Serial RS232 interfaces, 1 parallel interface, 64K RAM, Floppy Disk Controller, provisions for one 2732 EPROM — ALL ON THIS ONE BOARD!!

BSSDSSBC	Z80A SBC A&T	$895.00	$655.00
BSSDSCPM	CP/M® Operating System on 8" disk		$150.00
BSSDSTURBOS	Single User TurboDos™ on 8" disk		$450.00
BSSDSTURBOM	Multi-User TurboDos™ on 8" disk		$750.00

S-100 Z80A SLAVE SBC

Z80A 4MHz, 2 RS232 Serial ports, 4 parallel ports, 64K RAM, EPROM Programmer. Used in multi-user computer system with SDSSBC.

BSSDSSBCSE	Slave Z80 SBC A&T	$825.00	$565.00

California Computer Systems

64K - 4MHz IEEE/S-100 DYNAMIC RAM

• Operates with either an 8080 or Z-80, providing processor transparent refreshes • Bank-select system • Any 16K block can be made bank-independent • Phantom input • Assembled & Tested

REGULAR LIST PRICE IS $375.00.

$175.00 each
4/$640.00

BSCCS20653 (Shipping Weight 2 lbs.)

RAM BOARD DISK DRIVE BONUS!

As an added bonus, PRIORITY ONE ELECTRONICS is giving away software developed by Micro Resources that will allow 4 CCS20653 boards to be used as an in-memory disk drive! This allows for an incredible speed increase in your computer! This software is available only with the purchase of 4 CCS20653 memory boards. Use Part Number **BSMRSHDSK**. (Shipping Weight: 1 lb.)

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S-100 MAINFRAMES

PARADYNAMICS

BSPDN2018D	18 slot desk top (45 lbs)	$660.00
BSPDN2018R	18 slot rack mount (45 lbs)	$695.00
BSPDN2818S	18 slot w/power-seq. floor standing (Shipped freight collect)	$1195.00
BSPDN2818	Same as above w/no power up seq (Shipped freight collect)	$1150.00

SIERRA DATA SCIENCES

BSSDSMF	12 slot mainframe (30 lbs)	$595.00
BSSDSWNMCP6	Same as above w/no poewr up seq (Shipped freight collect)	$595.00

Q.T. COMPUTER

BSQTCMF	Mainframe no motherboard (45 lbs)	$305.00
BSQTCMF12	12 slot mainframe (45 lbs)	$469.00
BSQTCMF18	18 slot mainframe (45 lbs)	$499.00
BSQTCMF22	22 slot mainframe (45 lbs)	$530.00
BSQTCMFMD	No motherboard cutouts for two 5¼" drives (45 lbs)	$345.00
BSQTCMFMD6	6 slot, two 5¼" cutouts (45 lbs)	$530.00
BSQTCMFMD12	12 slot, two 5¼" cutouts (45 lbs)	$560.00
BSQTCMFDD6	6 slot, two 8" cutouts (48 lbs)	$530.00
BSQTCMFDD8	8 slot, two 8" cutouts (48 lbs)	$595.00
BSQTCMFDD12	12 slot, two 8" cutouts (48 lbs)	$625.00

COMPUPRO

BSGBTENC20DK	20 slot desk top (Sh Freight Collect)	$658.95
BSGBTENC20RM	20 slot desk top (Sh Freight Collect)	$695.00

CompuPro

COMPLETE 8 BIT ENTRY LEVEL CP/M® BASED COMPUTER SYSTEM

LOOK AT WHAT YOU GET!

		List Price
BSGBT160A	6 MHz Z80 CPU	$325.00
BSGBT171A	DMA DiskController	$495.00
BSGBT206SP	Dual QUME Drives and Cabinet	$2395.00
BSGBT187A	3 Serial, 1 Parallel, 1 Centronics I/O	$399.00
BSGBTRAM17	64K Static RAM	$499.00
BSGBTENC20DK	20 Slot S-100 Mainframe	$825.00
BSGBTCPM80	CP/M 2.2® with BIDS	$175.00
BSGBTCBL4	3 Port Serial Cable to Cabinet	$ 44.00
BSGBTCBL9	Centronics Cable to Cabinet	$ 29.50
BSPGC50S80S	5' Drive Cable	$ 19.77

TOTAL PURCHASE VALUE: $5206.27

BUY IT NOW FOR ONLY:

$3495

BSPDBGBT8BT

SAVE $1711.27!!

DUAL QUME 8" FLOPPY DRIVE, CABINET, DMA S-100 CONTROLLER, AND CP/M® From CompuPro

$1595.00

BSPDBGBTSYS206 (Shipped freight collect)

YOU SAVE $1419.77!!

ABSOLUTELY THE MOST COST EFFECTIVE DISK SUBSYSTEM EVER OFFERED BY PRIORITY ONE ELECTRONICS

- 2 Double sided 8" QUME DT8 disk drives
- DMA Floppy Controller (controls up to 4 drives)
- CP/M 2.2® w/BIOS written for the Disk 1 Controller
- Cabinet includes power supply & internal data cable
- External data cable included

	List Price
1 GBT206SP	$2325.00
1 GBT171A	$495.00
1 GBTCPM80	$175.00
1 PGC50S60S	$ 19.77
	$3014.77

CABINET AND 2 QUME DT8 DOUBLE SIDED DRIVES PROVIDE 2.4 MBYTES OF MASS STORAGE!! $1295.00

SAVE $1030.00!!

BSGBT206SP (Sh Wt 50 lbs) List Price $2325.00

CompuPro

UN-SYSTEM 816

DIG DEEP!! Now is the time to buy the CompuPro UN-SYSTEM 816!!

SAVE MONEY, and have an UN-SYSTEM 816 for your very own! All UN-SYSTEMS contain the very same components as the SYSTEM 816s listed in our Winter 1983 Engineering Selection Guide, but are not installed or configured. All it takes is your professional computer experience and knowledge to have the highest performing S-100 computer system on the market today. BEWARE! This is not for the novice and inexperienced user, as it requires a well-matured knowledge in system integration procedures.

UN-SYSTEM 816/A
ENTRY LEVEL - SINGLE USER

Disk storage: 2.4 Megabytes. Expandable to 4.8 Megabytes.
Main memory: 128K - expandable to 1 Megabyte
Serial Ports: 4 / Parallel Ports: 1
Centronics/Epson ports: 1
Software: CP/M 2.2™, CP/M-86™, M-Drive, SuperCalc-86, dBase.
Component List Price: $6705.00 BSGBTUNSYSA16

OUR SALE PRICE: $4394.00 SAVE $2311.00!!

UN-SYSTEM 816/B
ENHANCED HIGH PERFORMANCE SINGLE USER SYSTEM

Disk Storage: 2.4 Megabytes. Expandable to 4.8 Megabytes.
Main memory: 256K - expandable to 1 Megabyte
Serial ports: 6
Software: CP/M 2.2™, CP/M-86™, M-Drive, SuperCalc-86™, dBase II™
Component List Price: $8497.00 BSGBTUNSYSB16

OUR SALE PRICE: $5594.00 SAVE $2903.00!!

UN-SYSTEM 816/C
HIGH PERFORMANCE MULTI-USER SYSTEM

Disk storage: 2.4 Megabytes. Expandable to 4.8 Megabytes.
Main memory: 384K - expandable to 1 Megabyte
Serial ports: 9
Software: CP/M 2.2™, CP/M-86™, MP/M 8-16™, M-Drive, SuperCalc-86™, dBase II™
Component List Price: $9295.00 BPGBTUNSYSC16

OUR SALE PRICE: $7194.00 SAVE $3442.00!!

ALL SYSTEMS SHIPPED FREIGHT COLLECT

64K 10MHz LOW POWER S-100 IEEE STATIC RAMs

RAM 17
64K 8 BIT
24 BIT ADDRESS
BSGBTRAM 17 List Price: $499.00
$299.00

RAM 16
64K 8 or 32K 16 BIT
24 BIT ADDRESS
BSGBTRAM16 List Price: $550.00
$325.00

VISA

PRIORITY ONE ELECTRONICS

9161 Deering Ave., Chatsworth, CA 91311

MasterCard

ORDER TOLL FREE (800) 423-5922 - CA, AK, HI CALL (213) 709-5111

Terms: U.S. VISA, MC, BAC, Check, Money Order, U.S. Funds Only. CA residents add 6½% Sales Tax. MINIMUM PREPAID ORDER $15.00. Include MINIMUM SHIPPING & HANDLING of $3.00 for the first 3 lbs. plus 40¢ for each additional pound. Orders over 50 lbs. sent freight collect. Just in case, include your phone number. Prices subject to change without notice. We will do our best to maintain prices through July, 1983. Many quantities are limited. Sorry, no rainchecks, no refunds or exchanges on sale merchandise. Credit Card orders will be charged appropriate freight. Sale prices for prepaid orders only. We are not responsible for typographical errors.

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SIXTH ANNIVERSARY SALE!

NOT JUST AN ORDINARY SALE! WE HAVE *SLASHED PRICES TO THE BONE* AS OUR WAY OF THANKING YOU, OUR VALUED CUSTOMERS FOR 6 YEARS OF LOYALTY. WE'VE CONTINUOUSLY GROWN AND EXPANDED BY OFFERING YOU THE BEST VALUE FOR YOUR MONEY WITH THE BEST AFTER-SALE SUPPORT

SIEMENS FDD100-8

8" FLOPPY DISK DRIVE

SINGLE SIDED, DOUBLE DENSITY
SHUGART 801R COMPATIBLE

90 DAY WARRANTY!

ONCE AGAIN, YOU RECEIVE THE BENEFIT OF OUR UNEQUALLED PURCHASING POWER!

$199.00 each

***$185.00* 2 to 9**

CALL for 10+

OEM INQUIRIES INVITED
(Include $7.00 per drive for shipping)
BSSIEFDD1008

ORDER NOW AND $AVE!

BUY DRIVE & CABINET TOGETHER AND $SAVE!!

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
OUR ANNIVERSARY PRICE:

$675.00
BSPOBIIISIE

BSIIIFOEOO2 CABINET ONLY (Sh Wt 38 lbs) ***$295.00***

S-100 DUAL 8" SUBSYSTEM

BSCCS2422A	S-100 Disk Controller with CP/M 2.2®	1	$399.00
BSSIEFDD1008	Siemens Double Density 8" drive	2	$398.00
BSIIIFDE002	Dual Horizontal Cabinet with Power Supply	1	$295.00
	and Data Cable	1	$ 35.00
			$1127.00

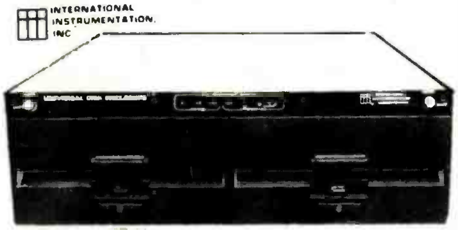
SAVE $132.00!!

$995.00
(Include $30.00 for shipping)

DON'T MISS OUT!
Order No.
BSPOBSIESUB1

OUR FINEST DUAL 8" DISK DRIVE CABINET!

INTERNATIONAL INSTRUMENTATION, INC



FEATURES:
- Positive pressure forced air cooling for reliable disk drive operation
- AC input via 3 wire 7 foot International cord/socket set
- AC Input EMI filtered to six amps to help prevent disk crashes due to power spikes and line noise
- 14 gauge main chassis
- Integral power supply with 5V @ 6A/-5V @ 1A/24V @ 6A
- Double-sided custom PC power board and supply
- Each DC supply and AC separately fused

Part No.		List Price	Our Price
BSIIIUDE004	(Sh. Wt. 40 lbs.)	$495.00	$425.00

With augmented power supply to handle Tandon Slimline, or Winchester disk drives. Includes the disk environment monitor.

BSIIIUDE004AUG	(Sh. Wt. 40 lbs.)	$733.00	$625.00

With Disk Environment Monitor for cool, reliable operation.

BSIIIUDE004EM	(Sh. Wt. 40 lbs.)	$584.95	$495.00

S-100 HARD DISK SUBSYSTEMS

by MORROW

COMPLETE WITH S-100 CONTROLLER, CP/M 2.2® AND MICROSOFT BASIC V5.2

Part No.	Description	List Price	Our Price
BSMDSM20S	20 Mbyte 8"	$4495.00	$3250.00
BSMDSM26S	26 Mbyte 14"	$4495.00	$3250.00

(Shipping Weights: M20: 37 lbs., M26 (3 boxes): 8, 26, & 45 lbs. each)

ADD-ON DRIVES

(Does not include software and controller)

BSMDSA8M10	10 Mbyte 8"	$2795.00	$2050.00
BSMDSA14M26	26 Mbyte 14"	$3495.00	$2675.00

(Shipping Weights: M10: 37 lbs; M26: (2 boxes): 26, & 45 lbs. each)

FLOPPY DISK DRIVES

TANDON 5¼"

BSTNDTM1001	1 Sided 48 TPI (Sh. Wt. 5 lbs.)	$225.00
		2 FOR $195.00 each
BSTNDTM1002	2 Sided 48 TPI (Sh. Wt. 5 lbs.)	$270.00
		2 FOR $245.00 each
BSTNDTM1003	1 Sided 96 TPI (Sh. Wt. 5 lbs.)	$275.00
		2 FOR $250.00 each
BSTNDTM1004	2 Sided 96 TPI (Sh. Wt. 5 lbs.)	$390.00
		2 FOR $365.00 each

MPI 5¼" FULL HEIGHT

BSMPI51*	1 Sided 48 TPI	$200.00
BSMPI52*	2 Sided 48 TPI	$270.00
BSMPI91*	1 Sided 96 TPI	$275.00
BSMPI92*	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

BSMPI501	1 Sided 48 TPI (Sh. Wt. 4 lbs.)	$260.00
BSMPI502	2 Sided 48 TPI (Sh. Wt. 4 lbs.)	$300.00
BSMPI901	1 Sided 96 TPI (Sh. Wt. 4 lbs.)	$300.00
BSMPI902	2 Sided 96 TPI (Sh. Wt. 4 lbs.)	$355.00

SHUGART 8" FULL HEIGHT

BSSHU801R	1 sided (18 lbs.)	$369.00

QUME 8" FULL HEIGHT

BSQMEDT8	2 sided (18 lbs.)	$490.00
		2 FOR $465.00 ea.

MITSUBISHI 8" FULL HEIGHT

BSMITM2894838	2 sided (18 lbs.)	$425.00

MPI 8" FULL HEIGHT

BSMPI41S	1 sided (11 lbs.)	$380.00
BSMPI42S	2 sided (11 lbs.)	$460.00

MPI 8" DUAL HALF HEIGHT

(SAME SIZE AS ONE FULL HEIGHT)

BSMPI41D	1 sided (22 lbs.)	$760.00
BSMPI42D	2 sided (22 lbs.)	$870.00

TANDON 8" HALF HEIGHT

BSTNDTM8481	1 sided (9 lbs.)	$395.00
		2 FOR $375.00 ea.
BSTNDTM8482	2 sided (9 lbs.)	$495.00
		2 FOR 475.00 ea.

MPI 8" HALF HEIGHT

BSMPI41M	1 sided (11 lbs.)	$380.00
BSMPI42M	2 sided (11 lbs.)	$460.00

5¼" DRIVE CABINETS

BSJMR1C5	Single 5¼" Cabinet (5 lbs.)	$69.00
BSJMR2C5	Dual 5¼" Cabinet (9 lbs.)	$89.00
BSJMR2C5C	JMR2C5 w/internal data cable (9 lbs.)	$99.00

DUAL 8" HALF HEIGHT FLOPPY CABINET

- 24V @ 4A, 5V @ 3A -5V @ 800ma
- Fan cooled
- Socketed power connections
- All supplies regulated

		List Price	Our Price
BSIIIDTL002	Dual Thin Line Cabinet (12 lbs.)	$225.00	$165.00

BUY THE CABINET & DRIVES AND $AVE!

With 2 Tandon Thinlines

BSPDBIIITND1	Cabinet w/2 TNDTM8481 - 1 sided (30 lbs.)	$ 885.00
BSPDBIIITND2	Cabinet w/2 TNDTM8482 - 2 sided (30 lbs.)	$1115.00

With 2 MPI Slimlines

BSPDBIIIMPI1	Cabinet w/2 MPI41M - 1 sided (30 lbs.)	$ 920.00
BSPDBIIIMPI2	Cabinet w/2 MPI42M - 2 sided (30 lbs.)	$1080.00

Options

BSIIIDTLMPIKIT	MPI drive adaptor mounting kit (2 lbs.)	$24.95
BSIIIDCCSNU	Shugart / AC/DC power connector kit (2 lbs.)	$14.95

(For full size single SA801 or compatible drives)

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APPLE II/IIe DISK DRIVES

Drive, Cartridges, DMA Controller, Cabinet and Power Supply

FULLY APPLE II & IIe COMPATIBLE!!

ADD-ON DRIVE
BSVIS3101 **$229.00**
DISK DRIVE WITH CONTROLLER
BSVIS53111 **$289.00**

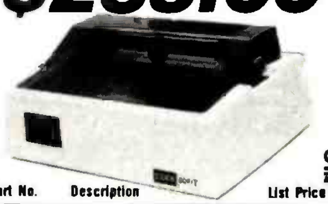
6 MEGABYTE DISK SUBSYSTEM

BSVIS1840 List Price: $1549.00 SALE: **$1299.00**

LOWEST COST PRINTERS AVAILABLE

$289.00!!

COEX 80 F/T by star



Part No.	Description	List Price	Our Price
BSCOX80FT	Parallel interface (21 lbs.)	$399.00	$289.00
BSCOX80FTSER	Serial Interface (21 lbs.)	$399.00	$289.00
BSCOXAPLINTP	Apple parallel interface w/cable		$49.95

$229.00

AXIOM
AXIOM CORPORATION

30 CPS
Parallel Interface

SAVE $160.00!!

BSAXMGP100A Dot Matrix Printer (11 lbs.) $389.00 **$229.00**

NOW! 20% FASTER AT SAME PRICE!

star gemini

120 CPS DOT MATRIX PRINTER

BSGEM10X 80 Column* Printer List Price: $399.00

SALE PRICE: $319.00
(Shipping Weight 20 lbs.)

BSGEM15 132 Column* Printer, 100 cps List Price: $649.00

SALE PRICE: $459.00
(Shipping Weight 26 lbs.)
*Based on 10 characters per inch.

SERIAL INTERFACE CARD FOR GEMINI 10 & 15
BSGEMSERINT Serial Interface Module (Sh. Wt. 1 lb.) $85.00

IBM® MULTICARD

Vista MEMORY & I/O CARD

- 64K RAM Expandable to 256K
- One RS232 Serial Port
- One Parallel Printer Port
- Real Time Clock Calendar with Battery Backup (Shipping Weight 1 lb.)

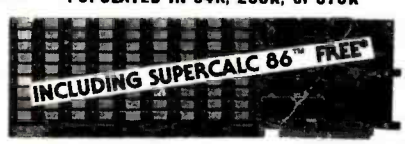
BSVIS025665 List Price: $595.00

ANNIVERSARY SALE PRICE:

$329.00

IBM® MAXICARD

Vista PERSONAL COMPUTER RAM CARD
POPULATED IN 64K, 256K, or 576K



- Runs at full speed with no wait states
- Parity can be disabled at User's option
- On board parity bit on each Byte
- Fully expanded, a full 576 KB on one card
- One board fills entire primary RAM address space available
- Full Vista 120 Day Warranty

64K $219.00
BSVIS057664 List Price: $379.00
SAVE $160.00!!

256K $489.00
BSVIS0576256 List Price: $789.00
SAVE $320.00!!

576K $849.00
BSVIS0576576 List Price: $1299.00
SAVE $450.00!!

* Available with 256K & 576K boards only (Sh. Wt. 6 lbs.)
(IBM is a trademark of International Business Machines)

5¼" FLOPPY DISKETTES

ULTRA MAGNETICS

DOUBLE DENSITY! LIFETIME WARRANTY!

FEATURES:
- Includes reinforcement ring
- 100% Surface tested
- Write protect with tabs
- Lifetime warranty!

SINGLE SIDED

40 TRACKS — DOUBLE DENSITY

1 BOX OF 10: **$ 25.00**
2 BOXES: **$ 40.00**
10 BOXES: **$180.00**

ORDERING INFORMATION
BSULT51401 Soft Sector
BSULT51410 10 Sector
BSULT51416 16 Sector

BSULT52401 Soft sector, 40 track, 2 sided
BSULT52410 10 sector, 40 track, 2 sided
BSULT52416 16 sector, 40 track, 2 sided

1 BOX OF 10	2 BOXES	10 BOXES
$35.00	$60.00	$280.00

MONITORS

MONOCHROME

TAXAN

Part No.	Description	List Price	Our Price
BSTAXKG12N	12" green (19 lbs.)	$179.00	$129.00
BSTAXKG12NUY	12" amber (19 lbs.)	$179.00	$129.00

SANYO

Part No.	Description	List Price	Our Price
BSSYODM8112CX	12" green (24 lbs.)	$260.00	$159.00

COLOR MONITORS

TAXAN

Part No.	Description	List Price	Our Price
BSTAXRGB1	12" med. res. RGB (29 lbs.)	$399.00	$328.95
BSTAXRGB3	12" high res. RGB (29 lbs.)	$699.00	$499.87

SANYO

Part No.	Description	List Price	Our Price
BSSYOVMC7013	13" NTSC w/sound (35 lbs.)	$650.00	$349.00
BSSYODM6113	13" RGB (35 lbs.)	$795.00	$499.00
BSSYOAVM255	25" RGB/NTSC	$795.00	$699.00

(25" Monitor shipped freight collect)

HEWLETT-PACKARD QUALITY & PERFORMANCE AT OUR *LOW* PRICES!!

SERIES 10 PROGRAMMABLE CALCULATORS

Part No.	Description	List Price	Our Price
BS HP-10C	Scientific	$ 70.00	$59.00
BS HP-11C	Adv. scientific	$ 90.00	$79.00
BS HP-12C	Adv. financial	$120.00	$99.00
BS HP-15C	Adv. sci. w/matrix	$120.00	$99.00
BS HP-16C	Digital & Computer science	$120.00	$99.00

(Shipping Weights on above calculators: 3 lbs. each)

HP-41C/CV HANDHELD COMPUTER SYSTEM

Part No.	Description	List Price	Our Price
BS HP-41C	Handheld computer	$195.00	$159.00
BS HP-41CV	Handheld computer w/5x the memory	$275.00	$219.00
BS HP82104A	Card reader	$195.00	$159.00
BS HP82153A	Optical Wand	$125.00	$ 99.00
BS HP82161A	Cassette drive	$450.00	$349.00
BS HP82162A	Thermal Printer	$450.00	$349.00
BS HP82163A	Video Interface	$225.00	$179.00

(Shipping Weights on above Items: 5 lbs. each)

ENHANCEMENT MODULES:

Part No.	Description	List Price	Our Price
BS HP82160A	HP-IL module	$125.00	$95.00
BS HP82170A	Quad RAM module	$ 75.00	$59.00
BS HP82180A	Extended functions/ memory module	$75.00	$59.00
BS HP82181A	Ext. memory module	$ 75.00	$59.00
BS HP82182A	Time module	$ 75.00	$59.00

(Shipping Weights on above items: 1 lb. each)

HP-75C PORTABLE COMPUTER

BS HP-75C (Sh. Wt. 9 lbs.) $995.00 **$795.00**

hp PERSONAL COMPUTATION DEALER

VISA **PRIORITY ONE ELECTRONICS** MasterCard
9161 Deering Ave., Chatsworth, CA 91311

ORDER TOLL FREE (800) 423-5922 - CA, AK, HI CALL (213) 709-5111

Terms: U.S. VISA, MC, BAC, Check, Money Order, U.S. Funds Only. CA residents add 6½% Sales Tax. MINIMUM PREPAID ORDER $15.00. Include MINIMUM SHIPPING & HANDLING of $3.00 for the first 3 lbs. plus 40¢ for each additional pound. Orders over 50 lbs. sent freight collect. Just in case, include your phone number. Prices subject to change without notice. We will do our best to maintain prices through July, 1983. Many quantities are limited. Sorry, no rainchecks, no refunds or exchanges on sale merchandise. Credit Card orders will be charged appropriate freight. Sale prices for prepaid orders only. We are not responsible for typographical errors.

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PRIORITY ONE IS YOUR PROTOTYPING SUPER-MARKET

page PLUGBOARDS

S-100 PLUGBOARDS

PART NO.	DESCRIPTION	1-4	5-9	10-24
BSPGBP1001	S-100 Bare Board	$15.95	$13.95	$11.95
BSPGBP1002	S-100 Horizontal Busses	$22.95	$19.95	$17.95
BSPGBP1003	S-100 Vertical Busses	$22.95	$19.95	$17.95
BSPGBP1004	S-100 Pads Per Hole	$23.95	$20.95	$18.95

APPLE PLUGBOARDS

BSPGBP5001	Apple bare board	$15.95	$13.95	$11.95
BSPGBP5002	Apple horizontal busses	$22.95	$19.95	$18.95
BSPGBP5004	Apple pads per hole	$23.95	$20.95	$18.95

UNIVERSAL PLUGBOARDS

4.5" x 6.5" or 9.6" edge connector as indicated for .3", .4", .6", .9" dips. Accommodates .1" IDC connectors at top of board.

BSPGBP4411	4.5"x6" 22/44 156" bare board	$ 8.95	$ 8.95	$ 7.95
BSPGBP4413	4.5"x6" 22/44 156" 2 holes per pad vertical busses	$13.95	$12.50	$11.50
BSPGBP4414	4.5"x6" 22/44 156" pad per hole	$14.95	$13.50	$12.50
BSPGBP4421	4.5"x9.6" 22/44 156" bareboard	$10.95	$ 9.95	$ 8.95
BSPGBP4423	4.5"x9.6" 22/44 156" 2 holes per pad vertical busses	$14.95	$13.50	$12.50
BSPGBP4424	4.5"9.6" 22/44 156" pad per hole	$15.95	$14.50	$13.50
BSPGBP5611	4.5"x6" 28/56 125 STD barebrd	$11.95	$10.95	$ 9.95
BSPGBP5613	4.5"x6" 28/56 125 STD 2 holes per pad vertical busses	$15.95	$14.50	$13.50
BSPGBP5614	4.5"x6" 28/56 125 STD pd/hole	$16.95	$15.50	$14.50
BSPGBP7211	4.5"x6" 36/72.1" bareboard	$ 8.95	$ 8.95	$ 7.95
BSPGBP7213	4.5"x6" 36/72.1" 2 holes per pad vertical busses	$13.95	$12.50	$11.50
BSPGBP7214	4.5"x6" 36/72.1" pad per hole	$14.95	$13.50	$12.50
BSPGBP7221	4.5"x9.6" 36/72.1" bareboard	$10.95	$ 9.95	$ 8.95
BSPGBP7223	4.5"x9.6" 36/72.1" 2 holes per pad vertical busses	$14.95	$13.50	$12.50
BSPGBP7224	4.5"x9.6" 36/72.1" pad per hole	$15.95	$14.50	$13.50

VECTOR IBM PC™ PLUGBOARDS

4.2" x 13.325" FR4 drilled & plated holes 31/62 contacts on .1 centers complete with card guide and mounting bracket that accepts "D" connectors

PART NO.	DESCRIPTION	1-5	6-24	25+
BSVCT4613	IBM 3 holes per pad with horiz. busses f/soldering 44 16 pin dip capacity	$39.00	$35.10	$31.20
BSVCT4613-1	IBM bare board 84 16 pin dips	$26.95	$24.26	$21.56
BSVCT4613-2	IBM horizontal busses for wire wrap 55 16 pin dip capacity	$36.95	$33.26	$29.56

IDC HEADER CONNECTORS

RIGHT ANGLE SOLDERTAIL GOLD HEADER

.1" Spacing Mounts on PC Board & Mates with IDC Socket above

Part No.	NO. OF PINS	1-9	10-24	PRICE 25-99	100-249	250-999
BSIDCRAH10ST	5/10	1.20	1.10	1.00	.80	.65
BSIDCRAH20ST	10/20	1.90	1.60	1.20	1.00	.85
BSIDCRAH26ST	13/26	2.25	2.00	1.55	1.25	1.05
BSIDCRAH34ST	17/34	2.95	2.80	2.05	1.70	1.45
BSIDCRAH40ST	20/40	3.60	3.00	2.40	2.00	1.70
BSIDCRAH50ST	25/50	4.30	3.60	3.00	2.50	2.10

RIGHT ANGLE WIRE WRAP GOLD HEADER

BSIDCRAH10WW	5/10	2.60	2.35	2.10	1.80	1.50
BSIDCRAH20WW	10/20	4.00	3.50	2.75	2.20	1.80
BSIDCRAH26WW	13/26	5.00	4.30	3.50	2.90	2.40
BSIDCRAH34WW	17/34	5.95	5.00	4.15	3.20	2.70
BSIDCRAH40WW	20/40	7.00	6.00	4.90	4.00	3.40
BSIDCRAH50WW	25/50	7.95	6.50	5.90	5.00	4.00

CALL FOR STRAIGHT HEADERS NOT LISTED

TEXAS INSTRUMENTS

16 PIN TIN DIP SOLDERTAIL SOCKETS

Qty	TIN BSTIS16LP
50 (Sh. Wt. 4 oz.)	$ 8.00
1000 (Sh. Wt. 4 lbs.)	$ 60.00
4500 (Sh. Wt. 15 lbs.)	$225.00

RS232 and "D" SUB-MINIATURE CONNECTORS

P=Plug, Male Type — S=Socket, Female Type

Part No.	No. of Pins	1-9	PRICE 10-24	25-99	100-249	250-999	1000+
BSCNDDE9P	9	$2.00	$1.80	$1.45	$1.35	$1.25	$1.05
BSCNDDE9S	9	$2.75	$2.40	$2.05	$1.85	$1.75	$1.60
BSCNDDA15P	15	$2.60	$2.30	$2.00	$1.80	$1.70	$1.55
BSCNDDA15S	15	$3.40	$3.00	$2.70	$2.50	$2.30	$2.15
BSCNDDB25P	25	$2.75	$2.50	$2.25	$1.95	$1.60	$1.35
BSCNDDB25S	25	$4.00	$3.50	$3.25	$3.00	$2.60	$2.25
BSCNDDC37P	37	$4.50	$4.00	$3.60	$3.30	$3.05	$2.80
BSCNDDC37S	37	$6.00	$5.40	$4.80	$4.30	$4.00	$3.70
BSCNDDD50P	50	$5.95	$5.35	$4.75	$4.25	$3.95	$3.60
BSCNDDD50S	50	$7.95	$7.20	$6.50	$6.00	$5.75	$5.50

"D" CONNECTOR HOODS

2 pc. Grey - Style A 2 pc Black - Style B 1 pc. Grey - Style C

Part No.	Pins/Style	1-9	10-24	25-99	100-249	250-999	1000+
BSCNDDE9C	9A	$1.50	$1.25	$1.10	$1.00	$ .90	$ .80
BSCNDDA15C	15A	$1.50	$1.25	$1.10	$1.00	$ .90	$ .80
BSCNDP25H	25A	$1.50	$1.25	$1.10	$1.00	$ .90	$ .80
BSCNDDB51226	25B	$1.75	$1.50	$1.35	$1.20	$1.10	$ .95
BSCNDDB51212	25C	$1.65	$1.40	$1.25	$1.15	$1.05	$ .90
BSCNDDC37C	37A	$1.75	$1.50	$1.35	$1.20	$1.10	$ .95
BSCNDDD50C	50A	$2.00	$1.75	$1.50	$1.30	$1.15	$1.00
BSCND20418	Hrdware set 2/Pr	$1.00	$ .80	$ .70	$ .60	$ .50	$ .40

CENTRONICS/EPSON PRINTER CONNECTORS

BSCND5730360	Solder	$9.00	$7.50	$6.00	$5.25	$4.50
BSIDC5730360	IDC	$9.95	$9.00	$8.00	$7.00	$6.00

IDC INSULATION DISPLACEMENT D-SUBMINIATURE CONNECTORS

P=Plug, Male Type — S=Socket, Female Type — C=Cover Hood

BSIDCDB25P	25	6.00	5.40	4.80	4.00	3.00
BSIDCDB25S	25	6.60	6.00	5.20	4.50	3.50
BSIDCDB25C	25	1.60	1.50	1.35	1.20	1.10

PLEASE CALL FOR IDC "D" CONNECTORS NOT LISTED

IDC SOCKET CONNECTORS

PART NO.	NO. OF PINS	1-9	10-24	PRICE 25-99	100-249	250-999
BSIDC10SKT	5/10	1.90	1.70	1.50	1.25	1.00
BSIDC20SKT	10/20	2.75	2.50	1.85	1.60	1.30
BSIDC26SKT	13/26	3.50	3.20	2.40	2.00	1.60
BSIDC34SKT	17/34	4.50	4.20	3.10	2.60	2.20
BSIDC40SKT	20/40	5.40	5.00	3.85	3.00	2.60
BSIDC50SKT	25/50	6.50	6.00	4.60	3.80	3.20

IDC PLUG CONNECTORS

.1" Spacing presses onto cable and mates with Socket Conectors above

BSIDC682010	10/20	5.50	5.20	4.80	4.40	4.00
BSIDC682610	13/26	6.25	5.65	5.00	4.50	4.10
BSIDC683410	17/34	7.00	6.25	5.70	5.00	4.60
BSIDC684010	20/40	7.50	6.75	6.00	5.25	4.95
BSIDC685010	25/50	8.50	7.50	6.50	6.00	5.70

CALL FOR PROTOTYPING SUPPLIES NOT LISTED

ROBINSON NUGENT, INC.

GOLD/TIN 3 LEVEL WIRE WRAP SOCKETS

PART NO.	PINS	STANDARD PCKGE.	EACH	PRICE 10-24	25-99	100-249	250-999
BSRNS08TWW	8	52	.55	N/A	.45	.41	.37
BSRNS14TWW	14	30	.65	.55	.50	.47	.44
BSRNS16TWW	16	26	.75	.65	.52	.51	.46
BSRNS18TWW	18	23	.90	.79	.75	.70	.65
BSRNS20TWW	20	21	1.10	.95	.91	.87	.82
BSRNS22TWW	22	19	1.25	1.15	1.05	.94	.89
BSRNS24TWW	24	17	1.25	1.15	1.05	.96	.89
BSRNS28TWW	28	15	1.50	1.45	1.35	1.25	1.15
BSRNS40TWW	40	10	2.00	1.80	1.60	1.40	1.30

*MINIMUM ORDER $1.00 per line item. To receive quantity prices beyond 1st Column you must order EXACT multiples of STANDARD PACKAGES

ICU SERIES SOLDERTAIL LOW PROFILE D.I.P. SOCKETS

PART NO.	PINS	STANDARD PKGE	EACH	10-49	50-99	100-499	500-999	1,000 +
BSRNS08LP	08	52	.25	N/A	.10	.08	.075	.07
BSRNS14LP	14	30	.25	.18	.15	.14	.12	.11
BSRNS16LP	16	26	.25	.20	.18	.18	.13	.12
BSRNS18LP	18	23	.30	.25	.22	.18	.15	.13
BSRNS20LP	20	21	.30	.25	.23	.20	.17	.145
BSRNS22LP	22	19	.35	.30	.25	.22	.18	.17
BSRNS24LP	24	17	.40	.35	.30	.24	.20	.18
BSRNS28LP	28	15	.45	.40	.35	.28	.24	.21
BSRNS40LP	40	10	.50	.45	.42	.40	.35	.31

*MINIMUM ORDER $1.00 per line item. To receive quantity prices beyond 1st column you must order EXACT multiples of STANDARD PACKAGES.

IDC EDGECARD CONNECTORS

PART NO.	NO. OF PINS	1-9	10-24	PRICE 25-99	100-249	250-999
BSIDC10CE	5/10	3.95	3.55	3.00	2.50	2.00
BSIDC20CE	10/20	4.35	4.00	3.30	2.50	2.10
BSIDC26CE	13/26	5.00	4.25	3.50	2.70	2.30
BSIDC34CE	17/34	6.00	5.40	4.50	3.50	2.90
BSIDC40CE	20/40	6.80	6.20	5.30	4.20	3.40
BSIDC50CE	25/50	7.25	6.60	5.90	4.90	3.90

RIBBON CABLE

COLOR CODED LAMINATED CABLE FOR INSULATION DISPLACEMENT 28 GAUGE, 7 STRAND

PART NO.	NO. OF CONDUCTORS	PRICE PER SPOOL 10 Ft.	200 Ft*
BSIDC10CC*	10	$ 3.80	$ 60.00
BSIDC14CC*	14	4.75	80.00
BSIDC16CC*	16	5.50	90.00
BSIDC20CC*	20	7.00	120.00
BSIDC25CC*	25	8.50	150.00
BSIDC26CC*	26	8.50	150.00
BSIDC34CC*	34	11.00	195.00
BSIDC40CC*	40	13.00	230.00
BSIDC50CC*	50	16.00	280.00

GRAY LAMINATED CABLE FOR INSULATION DISPLACEMENT 28 Gauge 7 Strand

BSIDC10GY*	10	2.50	$36.00
BSIDC14GY*	14	3.50	50.00
BSIDC16GY*	16	4.00	60.00
BSIDC20GY*	20	4.80	75.00
BSIDC25GY*	25	6.00	95.00
BSIDC26GY*	26	6.00	95.00
BSIDC34GY*	34	8.30	125.00
BSIDC40GY*	40	10.00	150.00
BSIDC50GY*	50	12.00	180.00

*Add "-200" to Part Number for 200 Ft. spool

PRIORITY ONE ELECTRONICS

9161 Deering Ave., Chatsworth, CA 91311

ORDER TOLL FREE (800) 423-5922 - CA, AK, HI CALL (213) 709-5111

Terms: U.S. VISA, MC, BAC, Check, Money Order, U.S. Funds Only. CA residents add 6½% Sales Tax. MINIMUM PREPAID ORDER $15.00. Include MINIMUM SHIPPING & HANDLING of $3.00 for the first 3 lbs. plus 40¢ for each additional pound. Orders over 50 lbs. sent freight collect. Just in case, include your phone number. Prices subject to change without notice. We will do our best to maintain prices through July, 1983. Many quantities are limited. Sorry, no rainchecks, no refunds or exchanges on sale merchandise. Credit Card orders will be charged appropriate freight. Sale prices for prepaid orders only. We are not responsible for typographical errors.

RETAIL STORE PHONE NUMBERS: (Chatsworth:) (213) 709-5464 - (IRVINE:) (714) 660-1411

Circle 327 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
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

LP = Low Power Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1 (250ns)	1.99
UPD411	4096 x 1 (300ns)	3.00
MM5280	4096 x 1 (300ns)	3.00
MK4108	8192 x 1 (200ns)	1.95
MM5298	8192 x 1 (250ns)	1.85
4116-300	16384 x 1 (300ns)	8/11.75
4116-250	16384 x 1 (250ns)	8/11.95
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
4164-200	65536 x 1 (200ns) (5v)	5.95
4164-150	65536 x 1 (150ns) (5v)	6.95

5V = single 5 volt supply

EPROMS

1702	256 x 8 (1us)	4.50
2708	1024 x 8 (450ns)	3.95
2758	1024 x 8 (450ns) (5v)	5.95
2716	2048 x 8 (450ns) (5v)	3.95
2716-1	2048 x 8 (350ns) (5v)	5.95
TMS2516	2048 x 8 (450ns) (5v)	5.50
TMS2716	2048 x 8 (450ns)	7.95
TMS2532	4096 x 8 (450ns) (5v)	5.95
2732	4096 x 8 (450ns) (5v)	4.95
2732-250	4096 x 8 (250ns) (5v)	8.95
2732-200	4096 x 8 (200ns) (5v)	11.95
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 Call	Call

5v = Single 5 Volt Supply

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		6	5,200	83.00
PE-14T	X	6	5,200	119.00
PE-24T	X	9	6,700	175.00
PL-265T	X	20	6,700	255.00
PR-125T	X	16	15,000	349.00
PR-320	X	32	15,000	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

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
3.579535	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	14.95
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	24.95
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	39.95
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
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
6862	11.95
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
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
TMS6011	5.95
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	74LS377	1.39
74LS122	.45	74LS378	1.18
74LS123	.79	74LS379	1.35
74LS124	2.90	74LS385	1.90
74LS125	.49	74LS386	.45
74LS126	.49	74LS390	1.19
74LS132	.59	74LS393	1.19
74LS133	.59	74LS395	1.19
74LS136	.39	74LS399	1.49
74LS137	.99	74LS424	2.95
74LS138	.55	74LS447	.37
74LS139	.55	74LS490	1.95
74LS145	1.20	74LS624	3.99
74LS147	2.49	74LS640	2.20
74LS148	1.35	74LS645	2.20
74LS151	.55	74LS668	1.69
74LS153	.55	74LS669	1.89
74LS154	1.90	74LS670	1.49
74LS155	.69	74LS674	9.65
74LS156	.69	74LS682	3.20
74LS157	.65	74LS683	3.20
74LS158	.59	74LS684	3.20
74LS160	.69	74LS685	3.20
74LS161	.65	74LS688	2.40
74LS162	.69	74LS689	3.20
74LS163	.65	74LS783	24.95
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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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	LM1800	2.37
LM301H	.79	LM348	.99	LM567	.89	LM1812	8.25
LM307	.45	LM350K	4.95	NE570	3.95	LM1830	3.50
LM308	.69	LM350T	4.60	NE571	2.95	LM1871	5.49
LM308H	1.15	LM358	.69	NE592	2.75	LM1872	5.49
LM309H	1.95	LM359	1.79	LM709	.59	LM1877	3.25
LM309K	1.25	LM376	3.75	LM710	.75	LM1889	1.95
LM310	1.75	LM377	1.95	LM711	.79	LM1896	1.75
LM311	.64	LM378	2.50	LM723	.49	ULN2003	2.49
LM311H	.89	LM379	4.50	LM723H	.55	LM2877	2.05
LM312H	1.75	LM380	.89	LM733	.98	LM2878	2.25
LM317K	3.95	LM380N-8	1.10	LM741	.35	LM2900	.85
LM317T	1.19	LM381	1.60	LM741N-14	.35	LM2901	1.00
LM318	1.49	LM382	1.60	LM741H	.40	LM3900	.59
LM318H	1.59	LM383	1.95	LM747	.69	LM3905	1.25
LM319H	1.90	LM384	1.95	LM748	.59	LM3909	.98
LM319	1.25	LM386	.89	LM1014	1.19	LM3911	2.25
LM320 (see 7900)		LM387	1.40	LM1303	1.95	LM3914	3.95
LM322	1.65	LM389	1.35	LM1310	1.49	LM3915	3.95
LM323K	4.95	LM390	1.95	MC1330	1.69	LM3916	3.95
LM324	.59	LM392	.69	MC1349	1.89	MC4024	3.95
LM329	.65	LM394H	4.60	MC1350	1.19	MC4044	4.50
LM331	3.95	LM399H	5.00	MC1358	1.69	RC4136	1.25
LM334	1.19	NE531	2.95	MC1372	6.95	RC4151	3.95
LM335	1.40	NE555	.34	LM1414	1.59	LM4250	1.75
LM336	1.75	NE556	.65	LM1458	.59	LM4500	3.25
LM337K	3.95	NE558	1.50	LM1488	.69	RC4558	.69
LM337T	1.95	NE561	24.95	LM1489	.69	LM13080	1.29
LM338K	6.95	NE564	2.95	LM1496	.85	LM13600	1.49
LM339	.99	LM565	.99	LM1558H	3.10	LM13700	1.49

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	4527	1.95
4001	.25	4528	1.19
4002	.25	4531	.95
4006	.89	4532	1.95
4007	.29	4538	1.95
4008	.95	4539	1.95
4009	.39	4541	2.64
4010	.45	4543	1.19
4011	.25	4553	5.79
4012	.25	4555	.95
4013	.38	4556	.95
4014	.79	4581	1.95
4015	.39	4582	1.95
4016	.39	4584	.75
4017	.69	4585	.75
4018	.79	4702	12.95
4019	.39	74C00	.35
4020	.75	74C02	.35
4021	.79	74C04	.35
4022	.79	74C08	.35
4023	.29	74C10	.35
4024	.65	74C14	.59
4025	.29	74C20	.35
4026	1.65	74C30	.35
4027	.45	74C32	.39
4028	.69	74C42	1.29
4029	.79	74C48	1.99
4030	.39	74C73	.65
4034	1.95	74C74	.65
4035	.85	74C76	.80
4040	.75	74C83	1.95
4041	.75	74C85	1.95
4042	.69	74C86	.39
4043	.85	74C89	4.50
4044	.79	74C90	1.19
4046	.85	74C93	1.75
4047	.95	74C95	.99
4049	.35	74C107	.89
4050	.35	74C150	5.75
4051	.79	74C151	2.25
4053	.79	74C154	3.25
4060	.89	74C157	1.75
4066	.39	74C160	1.19
4068	.39	74C161	1.19
4069	.29	74C162	1.19
4070	.35	74C163	1.19
4071	.29	74C164	1.39
4072	.29	74C165	2.00
4073	.29	74C173	.79
4075	.29	74C174	1.19
4076	.79	74C175	1.19
4078	.29	74C192	1.49
4081	.29	74C193	1.49
4082	.29	74C195	1.39
4085	.95	74C200	5.75
4086	.95	74C221	1.75
4093	.49	74C373	2.45
4098	2.49	74C374	2.45
4099	1.95	74C901	.39
14409	12.95	74C902	.85
14410	12.95	74C903	.85
14411	11.95	74C905	10.95
14412	12.95	74C906	.95
14419	7.95	74C907	1.00
14433	4.18	74C908	2.00
4502	.95	74C909	2.75
4503	.65	74C910	9.95
4508	1.95	74C911	8.95
4510	.85	74C912	8.95
4511	.85	74C914	1.95
4512	.85	74C915	1.19
4514	1.25	74C918	2.75
4515	1.79	74C920	17.95
4516	1.55	74C921	15.95
4518	.89	74C922	4.49
4519	.39	74C923	4.95
4520	.79	74C925	5.95
4522	1.25	74C926	7.95
4526	1.25	74C928	7.95
		74C929	19.95

74S00

74S00	.32	74S163	1.95
74S02	.35	74S168	3.95
74S03	.35	74S169	3.95
74S04	.35	74S174	.95
74S05	.35	74S175	.95
74S08	.35	74S181	3.95
74S09	.40	74S182	2.95
74S10	.35	74S188	1.95
74S11	.35	74S189	6.95
74S15	.35	74S194	1.49
74S20	.35	74S195	1.49
74S22	.35	74S196	1.49
74S30	.35	74S197	1.49
74S32	.40	74S201	6.95
74S37	.88	74S225	7.95
74S38	.85	74S240	2.20
74S40	.35	74S241	2.20
74S51	.35	74S244	2.20
74S64	.40	74S251	.95
74S65	.40	74S253	.95
74S74	.50	74S257	.95
74S85	1.99	74S258	.95
74S86	.50	74S260	.79
74S112	.50	74S274	19.95
74S113	.50	74S275	19.95
74S114	.55	74S280	1.95
74S124	2.75	74S287	1.90
74S132	1.24	74S288	1.90
74S133	.45	74S289	6.89
74S134	.50	74S301	6.95
74S135	.89	74S373	2.45
74S138	.85	74S374	2.45
74S139	.85	74S381	7.95
74S140	.55	74S387	1.95
74S151	.95	74S412	2.98
74S153	.95	74S471	4.95
74S157	.95	74S472	4.95
74S158	.95	74S474	4.95
74S161	1.95	74S482	15.25
74S162	1.95	74S570	2.95
		74S571	2.95

INTERFACE

8T26	1.59
8T28	1.89
8T95	.89
8T96	.89
8T97	.89
8T98	.89
DM8131	2.95
DP8304	2.29
DS8835	1.99
DS8836	.99

MISC.

TMS99532	29.95
ULN2003	2.49
3242	7.95
3341	4.95
MC3470	4.95
MC3480	9.00
11C90	13.95
95H90	7.95
2513-001 UP	9.95
2513-002 LOW	9.95

VOLTAGE REGULATORS

7805T	.75	7905T	.85
78MO5C	.35	7908T	.85
7808T	.75	7912T	.85
7812T	.75	7915T	.85
7815T	.75	7924T	.85
7824T	.75		
7805K	1.39	7905K	1.49
7812K	1.39	7912K	1.49
7815K	1.39	7915K	1.49
7824K	1.39	7924K	1.49
78L05	.69	79L05	.79
78L12	.69	79L12	.79
78L15	.69	79L15	.79
78H05K	9.95	LM323K	4.95
78H12K	9.95	UA78S40	1.95

C, T = TO-220 K = TO-3
L = TO-92

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MM5369	3.95
MM5375	4.95
MM58167	8.95
MM58174	11.95
MSM5832	6.95

INTERSIL

ICL7106	9.95
ICL7107	12.95
ICL7660	2.95
ICL8038	3.95
ICM7207A	5.59
ICM7208	15.95

9000

9316	1.00
9334	2.50
9368	3.95
9401	9.95
9601	.75
9602	1.50
96S02	1.95

EXAR

XR 2206	3.75
XR 2207	3.75
XR 2208	3.75
XR 2211	5.25
XR 2240	3.25

DATA ACQUISITION

ADC0800	15.55	DAC0808	2.95
ADC0804	3.49	DAC1020	8.25
ADC0809	4.49	DAC1022	5.95
ADC0817	9.95	MC1408L6	1.95
DAC0800	4.95	MC1408L8	2.95

SOUND CHIPS

76477	3.95
76489	8.95
AY3-8910	12.95
AY3-8912	12.95
MC3340	1.49

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2764 64K EPROM $9.95

PROMS

Order by National Part	Function	TI	SIG	MIMI	Harris	
		EQUIVALENT PART NUMBERS				
74S188	32x8 OC	18SA030	82S23	6330-1	7602	1.95
74S287	256x4 TS	24S10	82S129	6301-1	7611	1.90
74S288	32x8 TC	18S030	82S123	6331-1	7603	1.90
74S387	256x4 OC	24SA10	82S126	6300-1	7610	1.95
74S471	256x8 TS	28L22		6309-1		4.95
74S472	512x8 TS	28S42	82S147	6349-1	7649	4.95
74S473	512x8 OC	28SA42	82S146	6348	7648	10.95
74S474	512x8 TS	28S46	82S141	6341	7641	4.95
74S475	512x8 TS	28SA46	82S140	6340	7640	12.95
74S478	1Kx8 TS	28S86				19.95
74S570	512x4 OC	27S12	82S130	6305	7620	2.95
74S571	512x4 TS	27S13	82S131	6306-1	7621	2.95
74S572	1kx4 OC	24SA41	82S136	6352-1	7642	9.95
74S573	1kx4 TS	24S41	82S137	6353-1	7643	9.95
87S180	1kx8 OC	28SA86	82S180	6380-1	7680	19.25
87S181	1kx8 TS	28L86	82S181	6381-1	7681	16.25
87S184	2kx4 OC	24SA81	82S184		7684	17.20
87S185	2kx4 TS	24S81	82S185		7685	16.95
87S190	2kx4 OC	28SA166	82S190		76160	39.95
87S191	2kx8 TS	28S166	82S191		76161	39.95

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CAPACITORS

TANTALUM

	6V	10V	15V	20V	25V	35V	50V
.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						

DISC

10pf	50V	.05	470	50V	.05
22	50V	.05	560	50V	.05
25	50V	.05	680	50V	.05
27	50V	.05	820	50V	.05
33	50V	.05	.001uf	50V	.05
47	50V	.05	.0015	50V	.05
56	50V	.05	.0022	50V	.05
68	50V	.05	.005	50V	.05
82	50V	.05	.01	50V	.07
100	50V	.05	.02	50V	.07
220	50V	.05	.05	50V	.07
330	50V	.05	.1	12V	.10
			.1	50V	.12

MONOLITHIC

.1uf-mono	50V	.18	.47uf-mono	50V	.25

ELECTROLYTIC

RADIAL			AXIAL		
.47uf	50V	.14	1uf	50V	.14
1	25V	.14	4.7	16V	.14
2.2	35V	.15	10	16V	.14
4.7	50V	.15	10	50V	.16
10	50V	.15	22	16V	.14
47	35V	.18	47	50V	.20
100	16V	.18	100	15V	.20
220	35V	.20	100	35V	.25
470	25V	.30	150	25V	.25
2200	16V	.60	220	25V	.30
			330	16V	.40
			500	16V	.42
			1000	16V	.60
			1500	16V	.70
			6000	16V	.85

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14 pin ST	.15	.12
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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		
8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
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40 pin WW	1.99	1.80
WW = WIREWRAP		
16 pin ZIF	6.75	call
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ZIF = TEXTOOL (Zero Insertion Force)		

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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

For order instructions see "IDC Connectors" below.

POWER SUPPLY

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MOUNTED ON PC BOARD

MANUFACTURED BY CONVER

+5 VOLT 4 AMP

±12 VOLT 1 AMP

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IDCEN36	Ribbon Cable	36 Pin Male	8.95
CEN36	Solder Cup	36 Pin Male	7.95

RIBBON CABLE

CONTACTS	SINGLE COLOR		COLOR CODED	
	1'	10'	1'	10'
10	.50	4.40	.83	7.30
16	.55	4.80	1.00	8.80
20	.65	5.70	1.25	11.00
25	.75	6.60	1.32	11.60
26	.75	6.60	1.32	11.60
34	.98	8.60	1.65	14.50
40	1.32	11.60	1.92	16.80
50	1.38	12.10	2.50	22.00

D-SUBMINIATURE

DESCRIPTION	SOLDER CUP		RIGHT ANGLE PC SOLDER		IDC RIBBON CABLE		HOODS	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	BLACK	GREY
ORDER BY	DBxxP	DBxxS	DBxxPR	DBxxSR	IDBxxP	IDBxxS	HOOD-B	HOOD
CONTACTS 9	2.08	2.66	1.65	2.18	3.37	3.69	—	1.60
15	2.69	3.63	2.20	3.03	4.70	5.13	—	1.60
25	2.50	3.25	3.00	4.42	6.23	6.84	1.25	1.25
37	4.80	7.11	4.83	6.19	9.22	10.08	—	2.95
50	6.06	9.24	—	—	—	—	—	3.50

For order instructions see "IDC Connectors" below.

CALL FOR MOUNTING HARDWARE

IDC CONNECTORS

DESCRIPTION	SOLDER HEADER	RIGHT ANGLE SOLDER HEADER	WW HEADER	RIGHT ANGLE WW HEADER	RIBBON HEADER SOCKET	RIBBON HEADER	RIBBON EDGE CARD
ORDER BY	IDHxxS	IDHxxSR	IDHxxW	IDHxxWR	IDSxx	IDMxx	IDExx
CONTACTS 10	.82	.85	1.86	2.05	1.15	—	2.25
20	1.29	1.35	2.98	3.28	1.86	5.50	2.36
26	1.68	1.76	3.84	4.22	2.43	6.25	2.65
34	2.20	2.31	4.50	4.45	3.15	7.00	3.25
40	2.58	2.72	5.28	4.80	3.73	7.50	3.80
50	3.24	3.39	6.63	7.30	4.65	8.50	4.74

ORDERING INSTRUCTIONS: Insert the number of contacts in the position marked "xx" of the "order by" part number listed. **Example:** A 10 pin right angle solder style header would be IDH10SR.

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Circle 223 on inquiry card.

Unclassified Ads

NEED: OSI Superboard information on how to add memory I/O ports, real-time clock, etc. In return, I have information and miscellaneous programs for the Apple. Gary De Pietro, 752 Commerce St., Thornwood, NY 10594.

FOR SALE: Explorer-85 Microprocessor Kit by Netronics R & D. Kit includes power supply, keypad, motherboard, assembly manuals, Osborne's 8085 Assembly Language Handbook, and an S-100 bus handbook. Kit is expandable to a 64K-byte personal computer. Approximate value $275; asking $200. Roger Spaulding, 2514 West Bott, Colorado Springs, CO 80904, (303) 630-8164 or 593-3318.

FOR SALE: Heath H-8 32K serial and parallel I/O, cassette and disk interface, external configuration (for CP/M), wirewrap card, extender card, H-9 terminal, ASR33 hardcopy terminal: $1000. Two each 12-15 volt, 20 A power supplies: repairable @ $25. Ballentine 320 true RMS AC voltmeter: $25. Conrac 9-inch video monitor: $35, and a Tektronix RM35 oscilloscope: $250. Dave Marshall, 1803 Scenic Dr., Alamogordo, NM 88310, (505) 437-6374.

FOR SALE: Four disk drives Shugart SA-450, double sided double density, raw drive, no power supply or case: $195 each. Two Intel single-board computers, SBC 80/10: $125 and SBC 80/10A: $150. DEC LA36 logic board: $75. Please include shipping cost. Dean Carpenter, 163 Skyline Dr., Plano, TX 75074, (214) 424-3943.

FOR SALE: Teletype in excellent condition with paper-tape unit. Used as a standby terminal for four years. Annual maintenance check by terminal service company. Has stainless steel trays for paper supply and paper catcher. Unit has normal two wheels plus steel dolly with four furniture casters. Line-A-Time paper feed included: $650 FOB, Bay area. J. L. Morrissey, 1683 Galvez Ave., San Francisco, CA 94124, (415) 647-2188 days and 854-3497 evenings.

FOR SALE: Escon IBM Selectric Conversion Kit for Commodore computers. Complete with worn-out Selectric typewriter, $350. Ben A. Stewart, 501 Willow, West Baraboo, WI 53913, (608) 356-9246.

FOR SALE: AIM-65 with 4K RAM, assembler ROM, enclosure, power supply, MTU lowercase/80-column software, and all manuals: $300. Carl Schultz, 508 Cress St., Laguna Beach, CA 92651, (714) 497-5390.

FOR SALE: S-100 boards. Three 16K, 4 MHz static RAM boards (WAMECO MEM-2) with dipswitch bank select: $90 each. One 8K, 4 MHz static RAM board: $30. All in excellent condition. F. L. Stiles, 1128 Timbergrove Dr., Knoxville, TN 37919, (615) 691-0112 evenings.

WANTED: New or used print head for a Base 2 Model 800 dot-matrix printer or information about same. Dick Nowak, 340 Kingsland St., Nutley, NJ 07110, (201) 235-4989.

FOR SALE: TRS-80 Model I processor board, late model G board with schematic; tested and working: $125 less Z80 processor, ROM, and RAM ICs. Also, complete Model I 16K Level II with numeric pad: $325. Ed Bashur, 10457 Seawood, El Paso, TX 79925, (915) 592-1441.

FOR SALE: Heath H-14 line printer with RS-232C cable. Assembled and working but unused. Complete documentation: $395 or best offer. K. Hue, 1752 Las Vegas Trail #292, Fort Worth, TX 76108, (817) 246-5884.

FOR SALE: Dumont oscilloscope 100 MHz. Dual trace, delayed sweep, all active devices in sockets, all solid state, no proprietary parts whatsoever, all off-the-shelf. Used only two out of five years. Will trade for Commodore 64 and Smith-Corona TP-1, outright. M. Preston, 1132 A Pico Blvd., Santa Monica, CA 90405, (213) 452-2860.

FOR SALE: HP-85 computer with 32K RAM, 82905B printer, HP-IB interface, plotter/printer ROM, I/O ROM, Assembly ROM, carrying case, cables, cartridges, and software (Games II, Visicalc, and more). Will sell all or part. G.H. Smith, 531½ Gardner Way, Clifton, CO 81520, (303) 434-4443.

FOR SALE: TRS-80 Color Computer disk drive and controller, 20 Memorex double-density soft-sector floppy disks, Epson 8145 serial interface with cable, 6809 Assembly Language Programming by Leventhal, joysticks, Computerware Pac Man, Spectral Associates Space Invaders, Breakout. Items available separately. Any reasonable offer accepted. Bob Cent, 6826 47th Ave NE, Seattle, WA 98115, (206) 527-1883.

FOR SALE: Four 16K static RAM boards (fully socketed) for Heath H-8. Excellent condition. Includes manuals and schematics. Asking $100 each or all for $350. Willing to discuss trade. Will pay postage. Brian Aldiss, 37812 South Hardy Rd., Molalla, OR 97038, (503) 829-7825 after 7 p.m. PT.

FOR SALE: OSI computer, space boards, accessories. Send SASE for complete list and reasonable prices. Tom Badgett, 508 Woodland Dr., Bluefield, WV 24701.

WANTED: Crystalware programs for the Atari. Must have original documentation. Dave Palmer, 421 Chatsworth Lane, Canfield, OH 44406, (216) 533-6004, 5-9 p.m. ET.

FOR SALE: Complete Exidy System: Exidy Sorcerer II with Z80A, 48K RAM, 4K ROM plus 8K ROM Microsoft BASIC (removable), and is CP/M-compatible. S-100 expansion interface, Micropolis Model II subsystem with 315K on one drive, one serial port, one parallel port, graphics, and lots of software. Make an offer. Daniel Rappaport, 6109 Robinwood Rd., Bethesda, MD 20817, (301) 229-0308.

FOR SALE: Two S-100 memory boards. Logos I 8K static memory board with memory-protect and battery back-up circuitry on board. Godbout 8K EconoRAM static memory board with Vector interrupt option. Both in excellent condition: $65 each. Reeche Bass, 101 Caravan Villa, Montgomery, AL 36116, (205) 281-2210 after 5 p.m.

FOR SALE: Apple II Plus Computer, no disk drive or monitor, less than a year old, $1000. Tim Sullivan, 512½ Salzburg Apt. #2, Bay City, MI 48706, (517) 892-6319.

FOR SALE: Computer Devices Model 1206 portable briefcase-style computer. Includes 80-column thermal printer, built-in acoustic modem and tape drive, spare RS-232C port, full ASCII keyboard, editor, BASIC, and 6800 tape assembler. 6800-based with full documentation plus more. Hardly ever used: $1985 or best offer, retails at $3885. George Rourke, 69 Bay State Ave., Somerville, MA 02144, (617) 666-1117.

WANTED: Spanish-speaking microcomputer fans (especially technicians, engineers, and programmers) to exchange ideas and programs. Program Interchange, 41 Travers Ave., Yonkers, NY 10705.

FOR SALE: TRS-80 Model I, 48K RAM, two disk drives, cassette recorder, Centronics 737 printer, RS-232C, modem, lowercase modification, and powerline filter. Software includes NEWDOS/80, Scriptsit, Flextext, Omniterm, editor-assembler, system disk, and all cables and manuals. Excellent condition: $2000. Mike Plihcik, 810 Brown Rd., Bridgewater, NJ 08807, (201) 526-7125.

FOR SALE: Apple II Plus 80K with Mountain 32K card, Epson MX-100 Graftrax plus printer with parallel interface card, two Apple disk drives with controller, BMC green monitor, System Saver fan, Paddle Adapple, Novation Apple-cat modem with firmware, and 40 disks of software, including Pascal, Visicalc, word processors, and games. First $3550 takes it (I'll ship UPS COD). Adam Ginsberg, POB 2379, Albany, NY 12222, (518) 457-5261.

FOR SALE: Apple II with 48K, language card, Apple Disk II with controller, Applesoft ROM card, Zenith 12-inch green-phosphor monitor, and 40 disks of programs, including Apple Pascal 1.1 and Lisa 2.5. All hardware in mint condition, will ship in original boxes: $2300. Bill Rasmussen, 100 South Devine Rd., Vancouver, WA 98661, (206) 694-5958.

FOR SALE: Zenith Z-19 with cable, cover, and manual. Upgradable to H-89 computer: $650. Anderson-Jacobson 1235 acoustic coupler and modem with manual. Handles a 300 or 1200 data rate, asynchronous. Both hardly used, in excellent condition. Originally $995, will sacrifice for $650. Will sell separately or as package. Stanley Tsu, 2725 Haste St. #110, Berkeley, CA 94704, (415) 849-0182 or 661-0568.

FOR SALE: OSI C1P 16K with new C1S monitor, sound port, delay on reset key, screen invert, assembler/editor, and extended monitor programs. All manuals, schematics, and plenty of software included. The computer operates at twice the normal speed (2 MHz) and the cassette port operates at four times the normal speed: $270. I will add extra memory for $4 per K. Eric Praetzel, RR#1 Colgan, Ontario L0G 1G0, Canada, (416) 936-3032.

WANTED: I would like to exchange any hardware/software information, ideas, and programs with owners of the Cyzern System 7000/AN-7000. Dennis Lo, 1991 Suffolk Ave., Port Coquitlam, BC V3B 1H3, Canada.

WANTED: Experienced Atari assembly-language programmer to help me with DLIs, VBIs, display lists, scrolling, and animation for game-programming purposes. I already know assembly language. Will work out finances. Robert Schiller, 657 Calhoun Court, Herndon, VA 22070, (703) 437-5042.

FOR SALE: Apple II computer consisting of 256K memory, floppy-disk drive, 5 MB profile hard disk, Zenith monitor, COBOL, Business BASIC, Pascal, and single operating system. About 1 year old, still under manufacturer warranty. Also, QUME Sprint 5 printer and DEC VT-100 terminal with AVO. Rick Roth, 202 Parliament Dr., Coraopolis, PA 15108, (412) 262-5507 days and 262-4936 nights.

FOR SALE: Heath H-11 processor (hardly used), H-27 dual floppy-disk drive, H-9 video terminal, QUME Spring 5 letter-quality printer, and 30 8-inch floppy disks with attractive storage case. Asking $6000. Dr. Frank Pimentel, 582 North Main St., Wallingford, CT 06492, (203) 265-6089.

WANTED: Programs for the APF Imagination Machine. Eric Witt, POB 137, Germantown, OH 45327.

FOR TRADE: I am interested in exchanging software with other OSI users. Send a full list of your software and I will reciprocate with what I have. Malcolm Chew, c/o Jill Cappadona, POB 32276 UWF, Pensacola, FL 32514.

WANTED: A copy of the first issue of Radio Shack's TRS-80 Applications Sourcebook (26-2114). I will pay ten dollars to the first person who sends Volume I only. J.B. Flippin, POB 2331, Springfield, VA 22152.

FOR SALE: Exidy Sorcerer with 32K RAM, 8K standard basic ROM pack, S-100 expansion unit, S-100 Morrow Designs board, two RS-232C ports, two status ports, and four parallel ports. Includes joystick, joystick/sound adapter board, and all manuals. Also, more than six software programs. Hardware new: $2250, software new: $77; asking $1000 or best offer. Jean Pickett, 5 Buttonwood St., Hamilton, NJ 08619, (609) 586-2810.

FOR SALE: Apple-type joystick, in purchased condition. Also, Medfly Mania, Mission: Asteroid, and Space Warrior. All have original documentation, packages, and disks. All in mint condition: best reasonable offer. Gregg Johnson, 1041 Autumn Meadows, Westerville, OH 43081, (614) 891-3520.

WANTED: Apple games and utilities for trade. Please send list of programs when corresponding. Joe Staus, 107 Chapman Rd., Mankato, MN 56001.

FOR SALE: OSI C3A with 48K static RAM, dual 8-inch disk drives, and processors. Comes with 574 12-bit analog I/O-, 575 solderless prototyping-, CA-21 48-line parallel I/O-, and a 570 8-port interface, all for above boards. Also includes 550 16-port serial I/O, Hazeltine 1420, two operating systems, and 6502 BASIC and assembler, CP/M compatible. Includes all manuals and cables: new $9500, asking $6400. Chuck Swan, 60 Each Hintz Rd., Wheeling, IL 60090, (312) 537-3130.

FOR SALE: Motorola Dev. System (like new) includes M68DSK2 Exordisk II, floppy disk, MEX 6850 ACIA micromodule, MEX68P12 printer interface module, MEX6832-22 dynamic RAM module, MEX146805-MC146805 Micromodule, and 6809 Exorciser. W. Kautter, Box 566, Leola, PA 17540.

WANTED: One or two Hewlett-Packard 9830s or 9831s, working or not working. W.R. Flocks, 700 West Jackson #120, McAllen, TX 78501, (512) 682-6008.

WANTED: New or used Interact-R with hardware or software. Dr. H.S. Frank, 904 South Main St., Weatherford, TX 76086, (817) 599-7131.

FOR SALE: OSI C8P with 24K RAM and 8K ROM, 470 disk controller board, and RS-232C port. Hardly used, cost $1535; $500 or best offer. Adrian Segar, Solar Alternative Inc., 71 Main St., Brattleboro, VT 05301, (802) 257-4528 days, 257-1608 evenings.

WANTED: SAT tutorial program to run on an Osborne. P. Dawson, 284 Forest St., Oberlin, OH 44074.

WANTED: Apple II 48K to 64K, disk drive with controller, monitor, modem, and printer. Entire system or parts. Peter Van Horn, POB 113, Devon, PA 19333, (215) 647-4214.

FOR SALE: S-100 boards: SDS ExpandoRAM II 64K RAM with manual (48K installed), SDS ExpandoRAM I 64K RAM with manual, Tarbell Cassette interface without documentation, and new CompuPro active bus terminator with data sheet: $300 for all. Keith Musson, 904 Rolling Holly Dr., Great Falls, VA 22066.

FOR SALE: Alpha Micro AM-100 system with 16-bit processor, 6-port serial interface, 64K Piiceon RAM, 12-slot power supply, CDC 10MB Hawk drive with controller, operating-system software, and documentation. Perfect condition; all for $6500 or best offer; will sell separately. Cliff Russo, 359 Broadway, New York, NY 10013, (212) 966-0775.

WANTED: Schematics and/or technical data on Atari Video Computer System 2600. L. Cleburne Jacks, 581 Crescent Rd., Odessa, FL 33556, (813) 920-3592.

FOR SALE: OSI C1P 28K, 610 board, disk drive, two operating systems, cassette interface, sound, manuals, and lots of software. $545 takes all. J. Gurevich, 3420 Southwest 105 Ave., Miami, FL 33143, (305) 553-8762 evenings.

FOR SALE: Processor Technology Sol-20 with 48K RAM, 8080 processor, 5-slot S-100, 16 by 16 display, Solos module, Helios II dual 8-inch disk system with version 1.4.0 PTDOS. Also, DECwriter LA-36 interfaced to the Sol system, two 16K RAM S-100 boards, PT music system, 9-inch monitor, PT Access newsletters 1-1 to 2-1, and subscription to Proteus News. Helios and DECwriter not working: $2800. Todd Kaime, POB 675, Bloomfield, NM 87413.

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FOR SALE: Exidy Sorcerer 32K, BASIC, Sorcerer and BASIC manuals, technical and internals manuals, Leedex monitor, Backgammon, graphics games, US Map, and Plot cassettes: $600. Development ROMpak and manual: $80. Word Processor ROMpak and manual: $80. IDS 440G graphics printer and manual: $500. D.J. MacCrone, 1014 McClung Ave., Huntsville, AL 35801, (205) 536-1080.

WANTED: High school student interested in the computer field would appreciate a donated computer to experiment on. Jeff Savoy, 6412 Crestwood Circle, Madison, WI 53558.

FOR SALE: Printer, IDS 440 Paperiger (in superb condition) with graphics option and Apple-compatible parallel interface: $300. Sanyo 9-inch black-and-white monitor: $90. N. Halasz, 225 Dickinson St., San Diego, CA 92103, (619) 294-5870.

FOR SALE: Heath H-8 16K RAM, processor, and memory board. No I/O interfaces. Runs front-panel tests OK. Asking $250. John J. Kofroth, 25 Concord Rd., Darby, PA 19023, (215) 496-4000 ext. 5087 days and 237-6314 evenings.

FOR SALE: Altos 8000-2: $2750. ADDS Viewpoint: $350. Okidata 83A: $575. All items in perfect condition, with original packing and documentation. Perfect Writer and Supersoft FORTRAN available on 8-inch SSSD. Also, three ALF 3-voice music synthesizers for the Apple II: $165 each. Complete with cables, software, and documentation. Michael Morris, 26321 Delos Dr., Torrance, CA 90505, (213) 534-4132.

FOR SALE: Apple high-speed serial interface cards. Good working condition: $99. Chris Reiss, 5223 Edina Industrial Blvd., Minneapolis, MN 55435, (612) 835-5787.

FOR TRADE: Software for T/S 1000 and ZX81 in 16K. I will trade game and utility programs for programs of equal value; cassette only. Rod Hargis, Box 355, New Market, IA 51646.

FOR SALE: Heath H-89 processor board, cassette interface board, and tape software. These parts plus some power supply modifications can turn an H-19 terminal into a computer. $180. Tim Stanley, 12801 Roma Ave. NE, Albuquerque, NM 87123.

WANTED: Heath/Zenith H-19 video terminal, fully assembled, nearly new. J. Creamer, 139 Norstad Circle, Warner Robins, GA 31098, (919) 781-2398.

WANTED: Tape-transport covers (lids) for Phi-Deck tape drive (Mecca-Alpha) and information on running up to four Exatron stringy-floppies on one controller. C.T. Huth, 146 Schonhardt, Tiffin, OH 44883.

FOR SALE: Disks: 200 8-inch, single-sided, soft sectored; 20% are IBM single density, 70% are Dysan double density, 10% are others. Also, 20 Verbatim 5¼-inch, SSDD, 16-sector, certified 40 tracks. All are archival system backups with very low mileage. Fully guaranteed: $1.10 each postpaid. J.E. Matenkosky, 753 Jeffrey Dr., Greensburg, PA 15601.

FOR SALE: Apple II Plus-compatible system, 64K, single disk drive with controller and warranty. Will sell complete: $999 or separately. Pete H. Pan, 2504 Derbyshire Blvd. Apt. #5, Cleveland Heights, OH 44106, (216) 932-1578.

FOR SALE: Intertec Superbrain Jr. 64K, CP/M with MBASIC. Two floppy-disk drives with 328K. Two Z80A processors operating at 4MHz. $1500 postage paid. Robert Paradise, 528 North State St., Jackson, MS 39201, (601) 352-8149.

FOR SALE: Televideo 920C terminal with extra page of memory, vinyl cover, and Novation CAT acoustic modem; all in excellent condition: $550. Steve Rodia, 1734 Plateau Dr., Jackson, MI 49203, (517) 784-3255.

WANTED: Artec 32K-100 static RAM card, populated or not. Documentation not required. S. Cawn, 3647 Vinton Ave. #9, Los Angeles, CA 90034, (213) 836-0955.

FOR SALE: OSI C4P MF, 24K RAM, 5-inch disk drive, real-time clock, 16 colors in two resolutions, programmable tone generator, DAC, modem interface, printer interface, AC remote interface, uppercase and lowercase, dual joysticks, RF modulator, OS-65D with Microsoft BASIC and assembler, and all manuals. Over $2200 value; asking $1500. Keith Thomas, (605) 348-8960 after 3 p.m.

FOR SALE: S-100 boards including four 16K Problem Solver Systems memory boards @ $150 each. Altair disk drive with controller @ $300, and other cards. Also, a Hazeltine 1510 terminal: $400. Richard Whiteman, 635 Holman Ave., Athens, GA 30606, (404) 546-8814.

WANTED: Apple II Plus users who would like to exchange programs, please send a list of your collection and you will receive a list of my large and diverse software programs. Lars Wiklund, POB 175, Edsbruk 59098, Sweden, Tel: 0493 70617.

WANTED: IBM PC software exchange. Have games, utilities, and Visicalc overlays. Send single-side formatted disk for one of mine or write. Also, looking for instructions on how to recreate FAT. James Greene, 34 Crab Apple Place, Stamford, CT 06903.

FOR SALE: Atari software collection: 30 programs on Maxell disks include the newest games: $95. Send check or SASE for a list of programs. P. Wu, 17941 Bascom St., Irvine, CA 92715.

WANTED: DI/AN Controls 9030 dot-matrix printhead. Can possibly use solenoid wire units from dead head to rebuild mine. Will pay any reasonable cost. Richard Shelden, 5225 Twilight Rd., Roanoke, VA 24019, (703) 362-5506.

WANTED: IBM Epson printer with cable for IBM PC. Also, Tandon disk drives and external cabinet with cable. Please send serial number and price. Also, will sell Visicalc IBM 256K complete with manual; make an offer. Jack Fischer, POB 14097, Tulsa, OK 74104.

WANTED: College student would appreciate any unwanted or broken computer equipment: boards, drives, etc. I will pay shipping. Brian T. Parr, 32 Millers Grove, Frankfort, NY 13340, (315) 895-7279.

FOR SALE: OSI C4P with Cegmon chip and Leedex Video 100 monitor plus lots of software, documentation, manuals, books, magazines, and users journals: $400 or best offer. Marc Kamionkowski, 22476 Rye Rd., Shaker Heights, OH 44122, (216) 991-2668 evenings and weekends.

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Ciarcia's Up Top Again

First place in the April BOMB contest goes (once again) to Steve Ciarcia for his "Build an RS-232C Breakout Box." Steve will get the $100 prize. Thomas Starnes came in second with "Design Philosophy Behind Motorola's MC68000, Part 1." He'll be awarded the $50 kitty. Third place goes to Tony Zingale for his article on "Intel's 80186: A 16-Bit Computer on a Chip."

Correspondence

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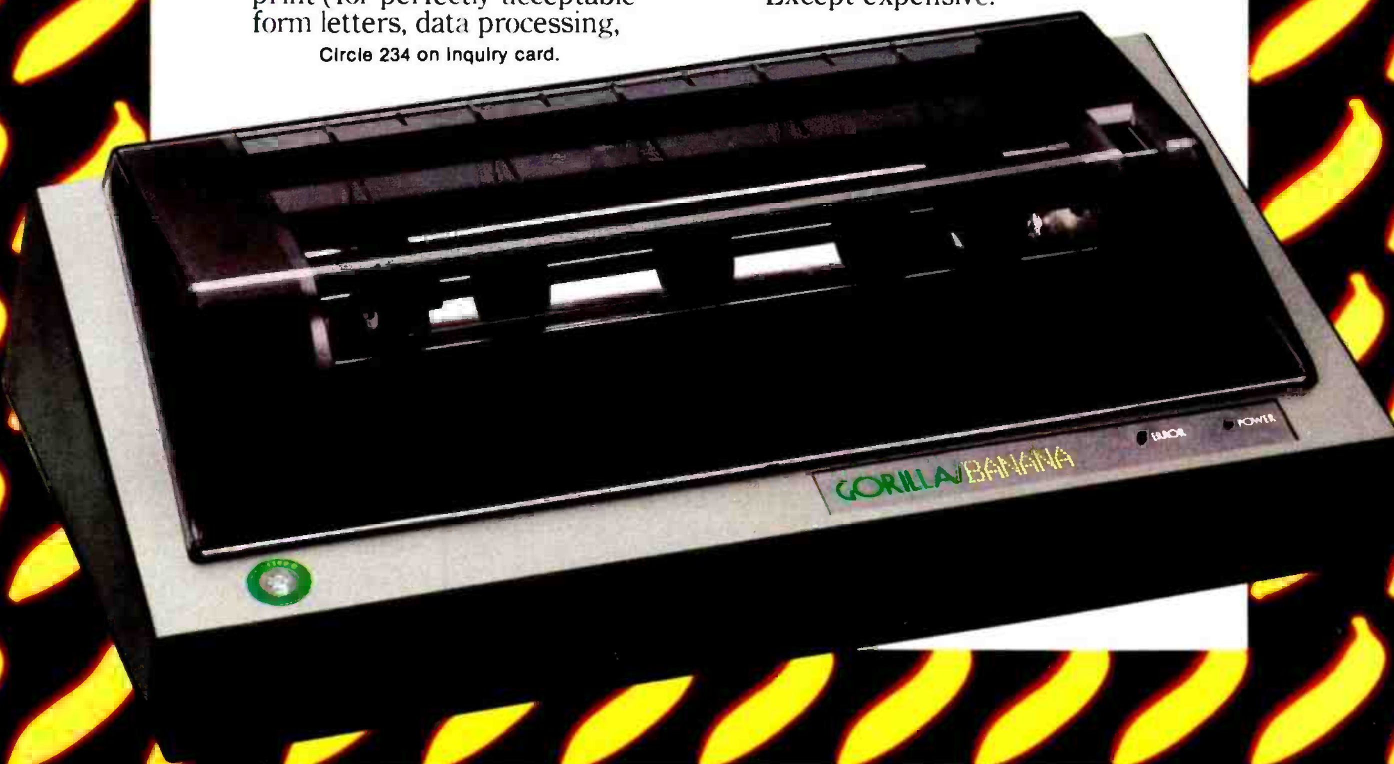

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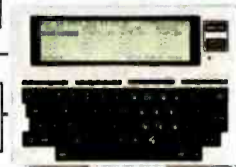

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