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the small systems journal

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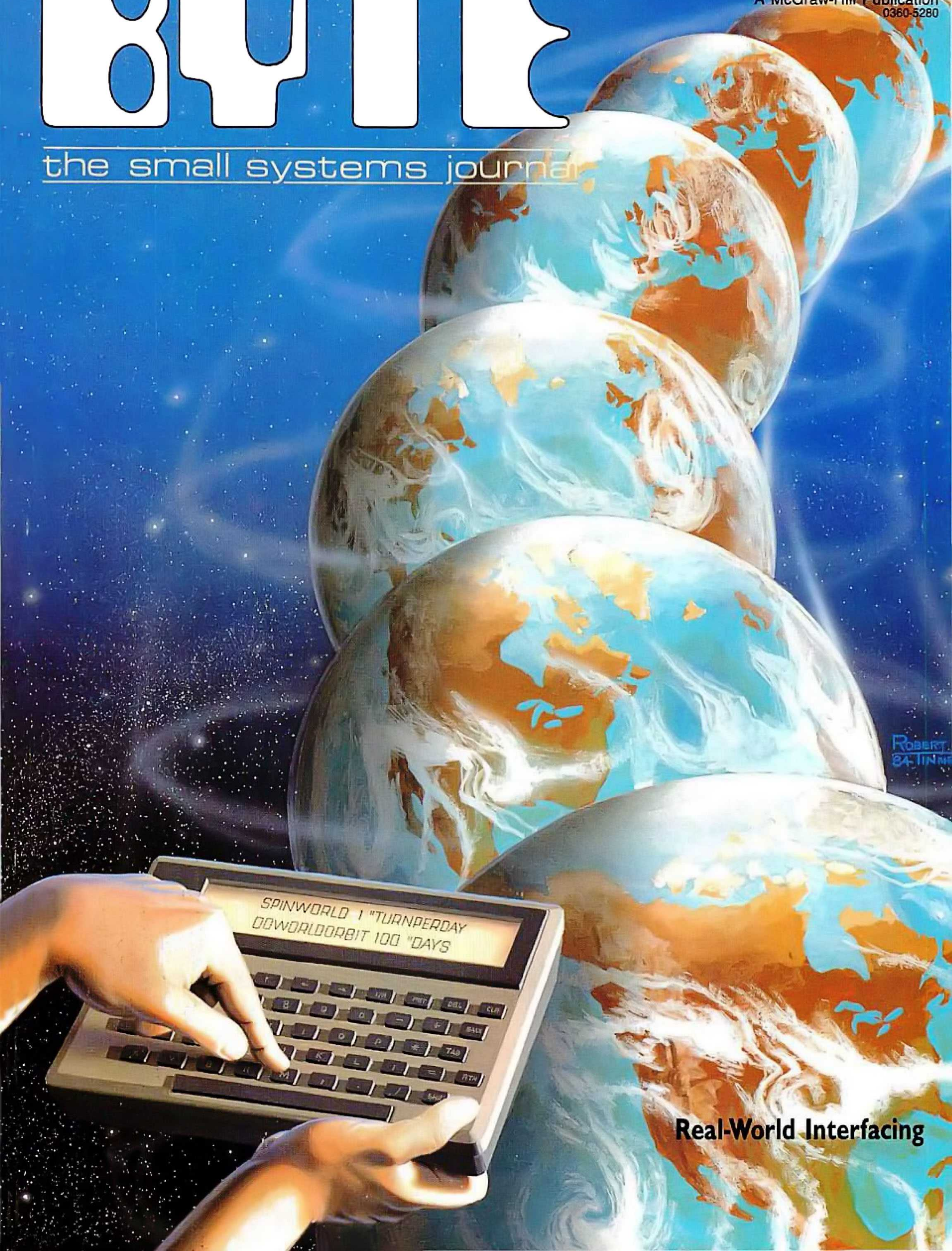
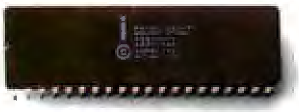


Real-World Interfacing

Introducing Macintosh. What makes it tick. And talk.

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

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



The garden variety 16-bit 8088 microprocessor.

Macintosh's 32-bit MC68000 microprocessor.

Some hard facts may be in order at this point:

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

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

Now for some small talk.

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

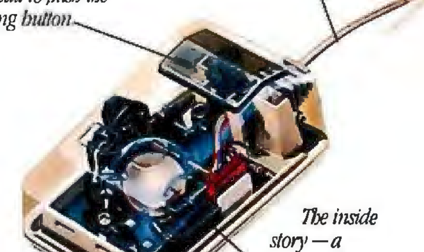
Another miracle of miniaturization is Macintosh's built-in 3½" drive. Its disks store 400K—more than conventional 5¼" floppies. So while they're big enough to hold a desk full of work, they're small enough to fit in a shirt pocket. And, they're totally encased in a rigid plastic so they're totally protected.

And talk about programming.

There are already plenty of programs to keep a Macintosh busy. Like MacPaint,™ a program that, for the first time, lets a personal computer produce virtually any image the human hand can create. There's more software on the way from developers like Microsoft,* Lotus,™ and Software Publishing Corp., to mention a few.

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

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



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

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

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

All the right connections.

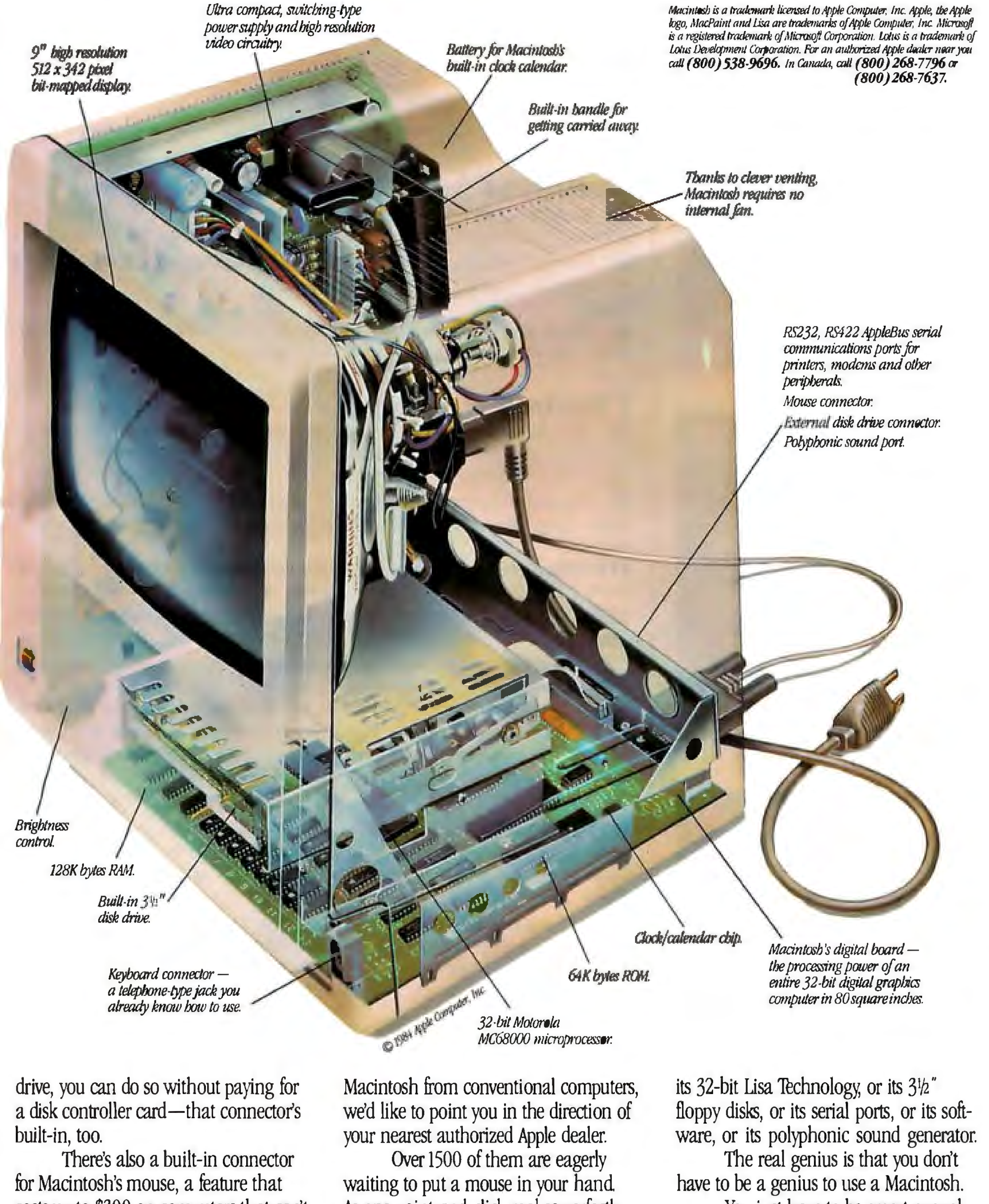
On the back of the machine, you'll find built-in RS232 and RS422 AppleBus serial communication ports. Which means you can connect printers, modems and other peripherals without adding $150 cards. It also means that Macintosh is ready to hook in to a local area network. (With AppleBus, you will be able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

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

Macintosh automatically makes room for your illustrations in the text.

MacPaint produces virtually any image the human hand can create.

Microsoft's Multiplan for Macintosh.



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

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

One last pointer.

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

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

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

You just have to be smart enough to buy one.

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

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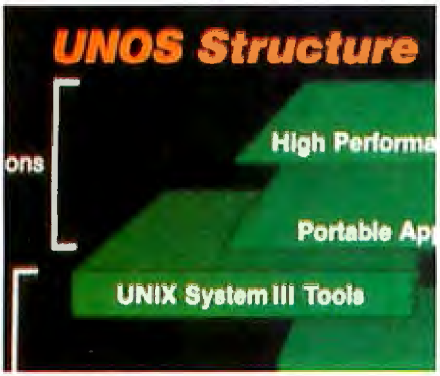

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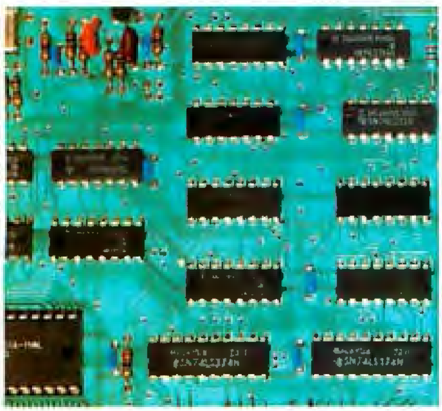
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Cover painting by Robert Tinney

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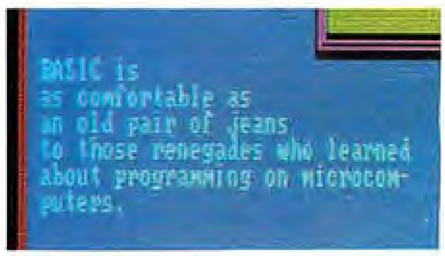

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A Call for Ethical Standards for Personal Computer Magazines

As a reader and a consumer, you have the right to know whether you can rely on the honesty and objectivity of articles in this and other personal computer magazines. Some common but unpublicized practices in this field raise serious ethical issues and can compromise a magazine's integrity. We want to inform you of these practices and to state our policies on them.

No "Editorial" Discounts for BYTE Staff Members

Some computer manufacturers and public relations agencies offer editors of personal computer magazines discounts of as much as 50 percent on both equipment and software. As a result, informed readers must wonder if a glowing article on a new computer was inspired by an honest evaluation or feelings of profound gratitude.

Discounts on hot new computers are a serious temptation for people who are as interested in computers as BYTE editors are, but we can't accept anything more valuable than a meal. We simply don't think that we or anyone else could remain objective after receiving such a favor.

Although staff members are not allowed to accept the loan of any equipment for their personal use, the magazine itself will accept long-term loans of single computers of each make in order to run software written for them. This policy applies equally to all manufacturers and is intended to help us extend coverage to more machines than we are able to buy. We return review machines unless the manufacturer offers to extend the loan to us, which seldom happens. To date, we have returned review disks of software, but the volume is now so enormous that we are considering keeping disks unless the publisher specifically requests return.

No Expense-Paid Trips

On occasion, BYTE receives invitations to send an editor on an expense-paid trip to a resort, a European capital, or some other almost irresistible setting for a "press conference." In principle, we can go on such a press excursion provided we pay our own way, all our competitors are going as well, and the trip has a legitimate journalistic purpose. But we don't believe that we can write objectively after flying free of charge to Paris or London and contemplating a new computer through a cloud of champagne bubbles. In practice, we just don't go on junkets, not even when told that all our competitors are going and that advertisements will be canceled if we don't go.

No Fat Speaker's Fees

BYTE staff members can't take money from advertisers or anyone likely to be the subject of coverage in BYTE. This applies to remuneration for speaking engagements. BYTE editors can accept paid transportation to the site of a speech but no fee for the speech beyond an honorarium of $50 or $100.

Disqualification from Stories because of Stock Ownership

No BYTE staff member can write about the products of any company in which he or she owns stock. For maximum journalistic freedom and objec-

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

68000-based systems to fit your application.

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

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

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

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

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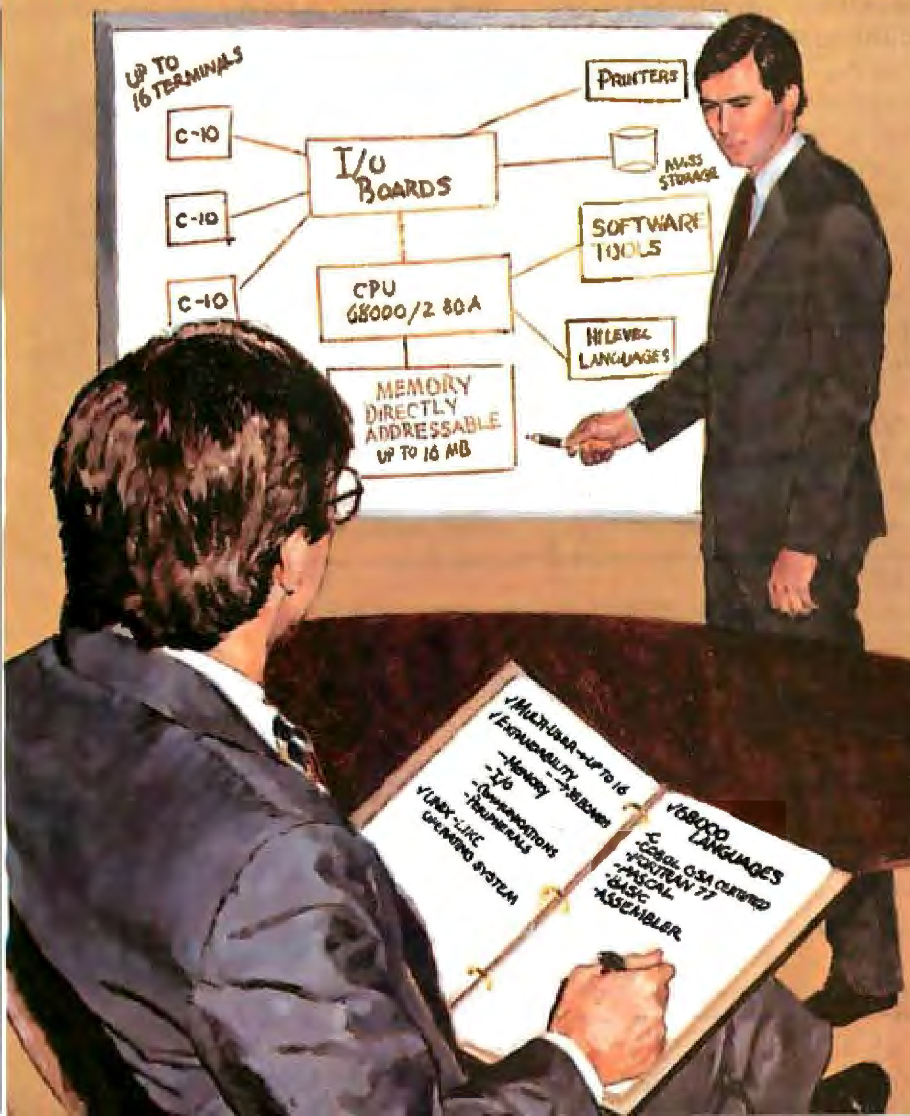

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tivity, BYTE staff members should avoid owning stock in any company that is part of the industry we cover.

An Author's Connections Must Be Clear

Many of the people who are doing interesting things with computers work in the personal computer industry. We want such people to write nonpromotional articles for BYTE that shed light on some interesting aspect of technology, but we require that the authors' company affiliations be stated with the article. This policy sometimes prevents us from publishing an article that we like. A case in point: one author works for a major manufacturer of personal computers but is writing as an enthusiast about aspects of personal computing that are not involved in his job. The manufacturer forbids the employee to mention the company name unless the article is job-related. We can't publish the article without stating the company name. The author is caught in between, but we value this policy more than any single article.

No Favoritism to Advertisers in Editorial Coverage

We write about products when we think that our readers will find them interesting. Decisions about editorial coverage are made without regard to whether related advertisements have been or will be placed in BYTE. Once in a great while, an advertiser who is accustomed to standards different from BYTE's will demand so-called "editorial support" and say that some other publications provide it and we don't. This is particularly awkward when we are planning to cover the related product anyway; we don't want the advertiser to think that we have bowed to pressure and will allot coverage on demand.

Editors Determine the Editorial Themes

Some editors at other publications have told us that the advertising department or business office sometimes tells them to do, let's say, an issue on "peripherals." Such issue themes are evidently wonderful frameworks around which to assemble advertisements. The editors of BYTE determine the themes of its issues independently. Our issues on simulation, real-world interfacing, computers and the disabled, benchmarks, Smalltalk, and so on, may not relate as directly to some advertisers' products as salespeople like. These themes do, however, attract readers who are intensely interested in computers. From the business standpoint, the hope is that these readers will see and act on the advertisements; reader surveys seem to bear this out. From the editorial standpoint, we choose themes based on their inherent interest and their appeal to our readers.

No Privileged Relationships with Companies in the Field

Although we enjoy working with companies well in advance of product announcements, we are glad that BYTE's welfare doesn't depend on the cooperation or the success of any single company in the industry. We prize our independence, our objectivity, and our freedom to cover what we choose in the manner we choose.

This is not to begrudge any company or companies their success or to say that machine-specific publications are necessarily bad. Nevertheless, we enjoy being exempt from the whole set of ethical issues confronting magazines that cover a single computer or a single company's computers. We can state our opinions without wondering what The Only Company will think. We can point out that The Only Machine has too little memory or a comparatively weak central processing unit or a power supply with hardly a milliampere to spare. Machine-specific magazines risk the loss of readers if they point out too many faults in The Only Machine. We serve our readers by pointing out all the faults we find.

The BYTE policies described above are nothing more than your due as a reader, and you may have believed that such policies go without saying at every magazine. But this is yet another area in which this young industry lacks standards. We pledge to do our best to safeguard our editorial integrity and to serve your interests as a personal computer user, and we call upon other magazines to do so as well.

—Phil Lemmons, Editor in Chief

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HeadStart Features:

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

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

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

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

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

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

*CP M is a re istered trademark of Digital Research.
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Intertec's HeadStart is the smallest, smartest, fastest, most powerful business computer money can buy.

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

Great Ideas Come In Small Packages.

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

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

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How Fast Is Fast?

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

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

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Some Ideas Are Bigger Than Others.

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

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

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

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

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

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

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MICROBYTES

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

IBM ANNOUNCES PORTABLE COMPUTER, PC CLUSTER, AND NEW VERSION OF SYSTEM 9000

IBM has introduced its own transportable version of the IBM PC. The IBM Portable Personal Computer (PPC) includes 256K bytes of RAM and a single disk drive for $2795; a second drive costs $425. The PPC includes five expansion slots to add optional printer and communications ports, but it includes a built-in 9-inch amber graphics monitor and interface for a color display. The PPC measures 20 by 17 by 8 inches, weighs 30 pounds, and includes a carrying case. While the PPC runs most software written for the PC, it can't run programs that are available only for MS-DOS 1.1 or that require an external monochrome monitor.

IBM also announced products that allow up to 64 IBM PCs, PPCs, PC XTs, and PCjrs to be interconnected. Each computer needs a $92 Cluster Program license and software, cables, and an interface device to the cluster. For the PC, PPC, and PC XT, a $375 Cluster Adapter can be installed in one of the expansion slots. A $400 Cluster Attachment fastens to the side of the PCjr entry level model, but because of power-supply limitations, it cannot be used with enhanced versions unless the disk drive, modem, and/or printer interface are disconnected. IBM says it will eventually offer a cluster interface for the enhanced PCjr; the other cluster products will be available in May.

A 9-foot cable connects each computer to a main cluster cable, which can be up to 3280 feet long. The hard disk on one PC XT or PC with a hard-disk expansion unit can be used as a master file server for the cluster. IBM sells a $110 cable kit, including two 9-foot cables and a 32-foot main cable, but says users are free to buy the 75-ohm cable and adapters elsewhere.

IBM also announced the 9002, a new version of its 68000-based IBM CS-9000 Lab Computer (see February 1984 BYTE, page 278). A base version of the 9002 is priced at $6495, while a four-user machine with a 10-megabyte hard disk and Microsoft's UNIX-based XENIX operating system is $15,960.

Also announced were graphics adapter cards and "image view" capabilities for IBM 3270 terminals and the 3270-PC. IBM says the image view software, which is for host computers, allows images input through IBM's Scanmaster to be displayed by 3270 terminals.

Unannounced: IBM is also said to be developing a multiuser computer based on Intel's 80186 chip, after reportedly abandoning plans to use Intel's 80286 due to that chip's production problems.

Perhaps most significant are reports that IBM is developing a proprietary operating environment, code-named "Glass." A direct competitor to Microsoft's Windows and VisiCorp's Visi On, Glass is said to use a mouse and include windowing while able to run major application programs. Reports differ on whether Glass runs under PC-DOS or a proprietary operating system IBM is said to be developing.

FOUR JAPANESE COMPANIES DISCUSS MEGABIT CHIPS AT SOLID-STATE CONFERENCE

Researchers from four Japanese corporations described experimental 1-megabit RAM devices at this year's International Solid-State Circuit Conference in San Francisco, while conference chairman Peter Verhofstadt of Fairchild Semiconductor stated that 4-megabit chips were now on the horizon.

Engineers from NTT, Hitachi, NEC, and Toshiba presented papers on 1-megabit chips with access times as low as 90 nanoseconds and on-chip error-checking and error-correction circuitry. The NEC design was laid out in a 128 by 8-bit configuration. NEC also discussed a megabit EPROM. Despite these experimental results, production of megabit RAMs is probably still several years away.

National Semiconductor and Texas Instruments presented papers on single-chip 1200-bps modems that respectively met Bell 202 and 212 standards.

ROSE BOWL SCOREBOARD SNAFU DONE WITH PORTABLE COMPUTER

During January's Rose Bowl, a scoreboard prank by two CalTech students was made possible by two computers and radio modems. The students, who are now being prosecuted for trespassing, used an Epson HX-20 notebook-size portable computer with an RF modem to tap into an 8086 breadboard they'd attached between the scoreboard and its operators. The students put several messages on the scoreboard's scratch-pad area and finally changed the names of the teams to show CalTech trouncing rival MIT, instead of UCLA beating Illinois. The students later held a seminar called "Packet RF Control of Remote Digital Displays."

FLAT-PANEL DISPLAY WILL COST SAME AS CRT

Binary Star Inc. has developed an incandescent flat-panel display that it says will be available for prices comparable to the cost of similar-sized CRT displays. The display will have both color and monochrome versions and can also display three-dimensional images. Flat-panel displays, which are thinner and lighter than CRTs but offer higher resolution than LCDs, permit greater portability. Binary Star hopes to begin production late this year.

NYNEX WILL SELL COMPUTERS, PHONES THROUGH RETAIL STORES

NYNEX, the regional operating company that includes New England Telephone and New York Telephone, will open two retail stores to sell computers, telephones, and other small-business equipment. Included will be IBM, Wang, and Compaq computers; NEC and Mannesmann Tally printers; and Tallgrass, Quadram, and Bizcomp peripherals. NYNEX's DataGo stores will stress training and in-house service centers.

NEW DATABASE SOFTWARE FLOODS SOFTCON FLOOR

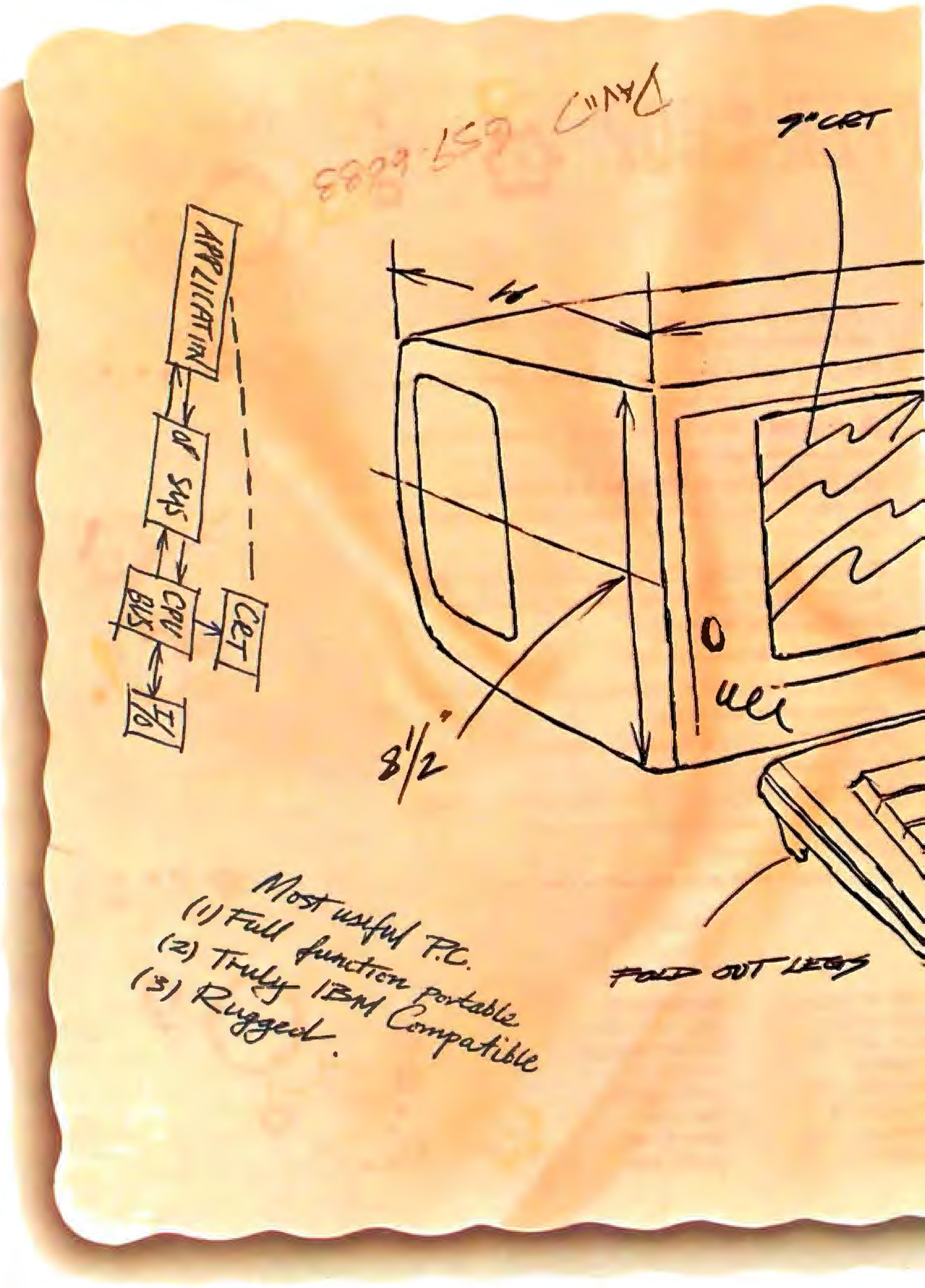
Although quite a few integrated software packages were introduced or shown at Softcon, a software trade show held in late February, new database-management software for the IBM PC seemed to dominate the floor.

Microstuf showed Infoscope, a $225 program boasting speed and user-friendliness. Leading Edge Products showed its $395 Nutshell Information Manager, which it says is not a true database manager but is easier to learn and use. ASAP Systems introduced ASAP Five, also $395.

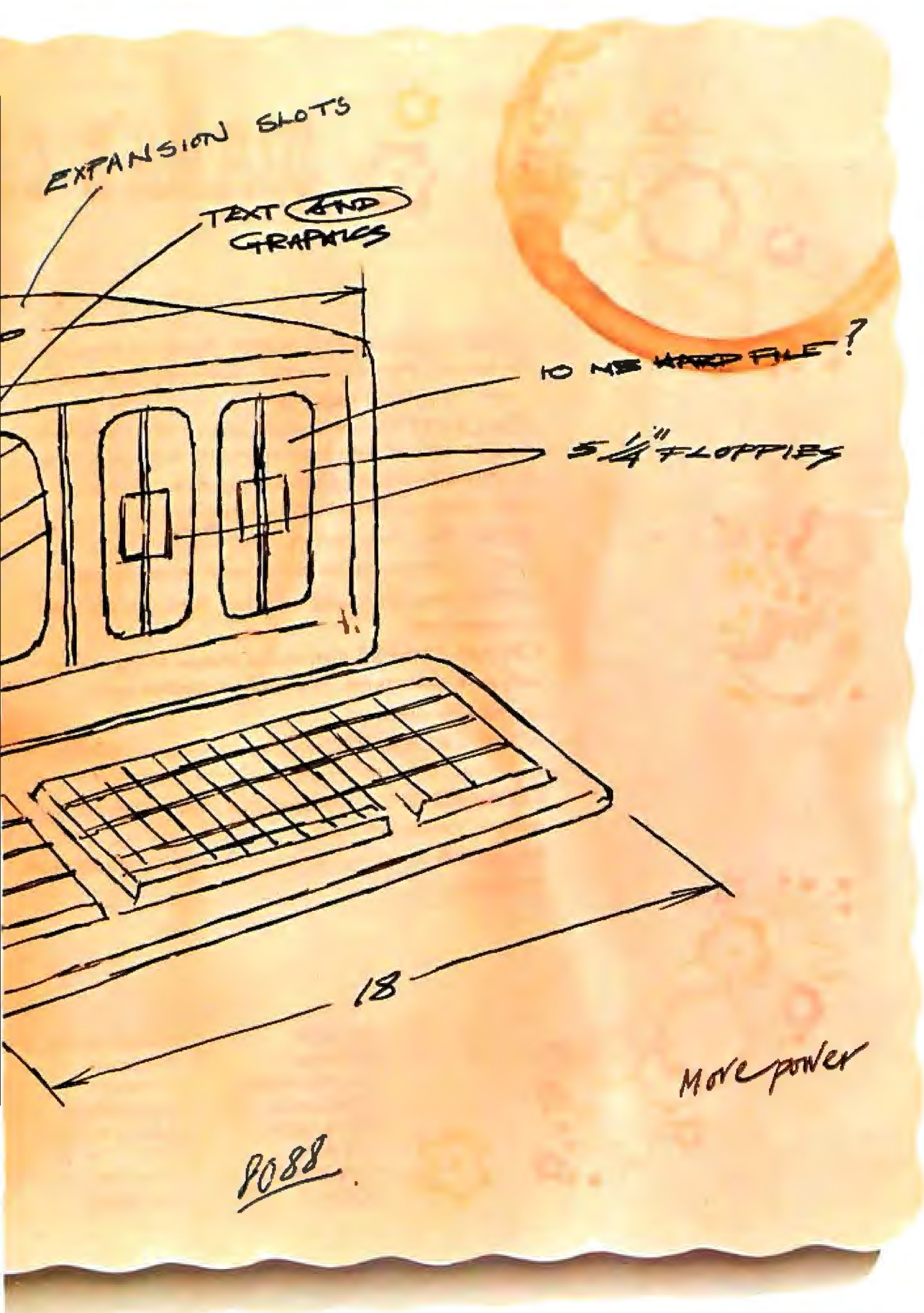
Advanced Business Computing Inc. unveiled Data Spectrum, with on-disk tutorials, for $239. Metasoft Corp. added several products to its Benchmark integrated software line, including data-management, spreadsheet, and telecommunications features.

NANOBYTES

Joystick maker **Amiga Corp.** is developing a 68000-based home computer with a custom graphics coprocessor. With 128K bytes of RAM and a floppy-disk drive, the computer will reportedly sell for less than $1000 late this year. . . .**Hewlett-Packard** is reportedly developing a 9-pound briefcase-size computer compatible with the HP 150. . . .**IBM, Sears, and CBS** announced that they are working on a joint videotex venture. The service would be made available to owners of many personal computers but will probably not be ready for several years. . . .**Ashton-Tate** has unveiled a multiuser version of dBASE II, its database-management software. . . .**Intel** has dropped the price of its BPK70-4 1-megabit bubble-memory subsystem from $199 to $149 (in 10,000-lot quantities). Intel said the price will drop to $99 by year-end. . . .Two companies have announced add-on array processor products for the IBM PC. **Helionetics Inc.** has a single-board array processor it says can increase the IBM's arithmetic speed up to 10,000 times for less than $2000. **Mercury Computer Systems** introduced the ZIP 3216, a $6000 three-board coprocessor subsystem that can be used with a number of microcomputers and minicomputers. . . .**The National Association of Working Women (9 to 5)** said that half of the pregnancies of VDT operators at a United Airlines office suffered adverse outcomes. The organization said that of 48 known pregnancies among the 300 persons working there, 24 were problem pregnancies. Ten to 15 other clusters of VDT operators with pregnancy problems have been reported by 9 to 5, which is seeking investigations into the health risks posed by VDTs. . . .**Hewlett-Packard** has introduced ThinkJet, a $495 ink-jet printer. . . .**Zenith Data Systems** has added five IBM PC-compatible desktop and portable computers to its Z-100 family. The Z-150 and Z-160 PCs include 128K bytes of RAM, two serial ports, one parallel port, RGB output, and four IBM-compatible expansion slots, with prices ranging from $2699 with one floppy-disk drive to $4799 with one floppy-disk drive and one hard-disk drive. . . .**Honeywell** announced plans to use the NCR/32, NCR's 32-bit microprocessor, in a future computer product. . . .**Digital Research Inc.** and **Motorola Inc.** have announced that DRI will produce a version of Concurrent DOS for Motorola's 68000 microprocessor. Concurrent DOS, which is version 3.1 of Concurrent CP/M-86, includes windowing and networking features, multiuser capabilities, and a "PC mode" that allows most PC-DOS software to run under Concurrent DOS. . . .**Diser,** the only commercial maker of Wirth's Lilith, a computer optimized for Modula-2, has stopped production and hopes to instead develop Modula-2 software for other systems. . . .**Kaypro Corp.** will sell a notebook-size computer made by **Mitsui**. The IBM-compatible portable was developed by a team including Microsoft's Kazuhiko Nishi, who helped develop Radio Shack's Kyocera-built Model 100 computer.



A picture worth $111,000,000.



Not long ago, three businessmen met in a coffee shop to talk about an idea for a new personal computer. They made a rough design on the back of a place mat.

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Oversimplified?

I read with interest Martin Dean's article "Simplify, Simplify, Simplify" (December 1983, page 161). Although many of his points are well taken, I think in his analysis of command-driven versus menu-driven programs he simplified too much.

He condemns command-driven programs, using the amusing analogy of a menuless restaurant in which the diner must describe to the chef the components of the meal. But Dean fails to see that command-driven and menu-driven is a false dichotomy.

A menu is a list of *commands*. The commands are typically context-sensitive, so that a "1" at one point in the program does something different than a "1" at another point, with the context being communicated by the menu itself. The menu lists all valid commands for the particular context, and the user thus can read from the menu the command she or he wants.

A so-called command-driven program normally (but not always) makes the user rely on memory (or a help card) for the command list, and usually also makes each command unique rather than interpreting the command by context: in effect, the main menu is the only menu, and it is not displayed.

But *not* displaying the menu in a command-driven program is not required. Wordstar is an example of a command-driven program, but it lists the commands in menus until the user knows them, whereupon the user can drop the menus. Wordstar constructs many of its commands by using two characters, with the first character defining the context and the second the action. (In the "Opening Menu" (formerly the "No-File Menu"), the menu defines the context and the command is a single character.)

I think the Wordstar approach is excellent: the commands are listed in a menu for new users, but those who know the package well can skip the menu and use the commands directly. To return to Dean's analogy, customers new to a good restaurant may go strictly by the menu, but people who know the restaurant can successfully request substitutions or even an entrée not on the menu. Good programs should allow their users the same flexibility of response: command menus should be at the user's discretion, not the designer's.

Michael Ham
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The Ultimate Allegory

Tom Houston's article "The Allegory of Software" (December 1983, page 210) was thought-provoking. After many seconds of intensive research, I believe I have developed the ultimate in icon screens—one that would permit every function currently imaginable and allow for future expansion.

I propose that each computer have screen icons that show a map of a city, complete with roads, businesses, and public services. The area of the city displayed would relate to the cost of the computer, with low-cost systems displaying the poor side of town, and high-cost systems on the rich side of town. Mainframes would be in large cities, microcomputers in smaller cities with more limited services. Sixteen- or 32-bit processors would be located on roads with quick access, while 8-bit machines would be on back streets. Parking garages would be provided for hard-disk systems, while floppy-disk-based system users would have to contend for on-street parking space. Systems used by office workers would probably be in the business district, while those used by managers would probably be located near golf courses.

Application progams would provide the necessary services (businesses within the city) and instructions on how to get from your office to them. For example, for accounting you would go to the accountant's office, while to build your database you might go to the library. Advertising copy would be sent to the advertising agency, financial spreadsheets kept in the bank, old files stored in the warehouse, etc.

To power up the system you would point to the electric utility. To print your program you would go to one of the printers in town, depending on the quality of work you needed and how much you wanted to pay. (The poor side of town might only have low-quality printers.) Computer programs would be ordered from the computer store, and supplies from the stationery store. When you went to lunch, you would park the cursor at the restaurant of your choice, stopping by the answering service on the way.

For modem communications you would go to the telephone company, for mail you would go to the post office, and high-speed full-duplex traffic would be via the divided highway. Networked systems could shift their screens to different parts of the city, or perhaps to a different city, where they would have access to that city's services. On the other hand, attempting to get too much traffic through a small system (on a back street, remember) would result in traffic jams and excessive delays.

In a big city (mini or mainframe system), there would be a wide variety of services for program development. The best graphics programs would be developed at the fine arts museum, while low-budget ones might be done at the local high school. Scientific programming could be done at the college. Low-cost programs could be developed in the low-rent district, where overhead is cheap.

There should be provision for general services as well; traffic cops for multiuser systems, clean-up crews for old data littering the streets, a city dump to dispose of obsolete programs, a towing service for occasional system crashes, a hospital where you would take your sick hardware, a city morgue for dead systems, and a cemetery for old ideas.

The city would probably offer routine spraying for bugs, but only on the rich side of town. The poor side of town is more likely to have detours (program patches) than the good side of town, and more potholes for your program to get lost in. The better systems, on the rich side of town, would have empty lots for future expansion, while the poor side of town would be too congested and wouldn't have room for expansion without demolishing some older programs.

These icons represent everyday occurrences for most people, rendering their computer experiences lifelike. Hardware failures could be represented by such things as stuck traffic lights or flat tires. Running a pirated program would lock up the cursor in the city jail for 30 days. And with today's sound effects, you could even give the cursor a simulated horn, so the operator could vent his frustrations at a stalled cursor. And might not we all feel on more familiar ground with our cursor stuck in a traffic jam between icons, while waiting for the system to complete a disk sort?

Gary Sanford
Measurement Engineering
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Lowell, MA 01853

A TI User Reports

I am a Texas Instruments Professional Computer user. I read "The Texas Instruments Professional Computer" by Mark Haas (December 1983, page 286) and I agree with some of the things the author said about it. It does stand a good chance of surviving in this competitive field.

I have the BASIC version 1.1 and Easywriter 1.1. The BASIC version 1.1 does have its faults, as the author described, but it suits my needs. I am a 14-year-old, high school freshman, and I am very much into computers. As you mentioned, the "motor" function (the Ctrl-Alt-Del command) does work to start the system over again. You don't have to turn the machine off and then back on again.

I have found that if I try to buy something from TI, it takes a long time to get a delivery. For instance, I had a new fan put in this machine because the one it came with was too noisy. I learned that TI put the noisy fans in because they didn't have the quieter ones. It took almost three months and at least a dozen calls to TI to get the fan delivered.

At the place I bought the Professional Computer, the service is not the best. The salespeople don't know how to operate some of the hardware nor some of the software. I went to look at the Omni 850 printer and they couldn't get it to work. I think it is awful that many salespeople do not know how to operate some of the things they are trying to sell.

Right now I am waiting for delivery of TI's 300/1200 internal modem and the software that comes with it. The salesperson I ordered it from said it wouldn't be in until February 1984. I can understand that it takes some time to send it, but I think three months is ridiculous (I ordered it in November).

Overall, I think the Texas Instruments Professional Computer is excellent, but the support and service could be greatly improved. Maybe after the computer has been out for a while, they'll get all the bugs straightened out.

David Solomons
11 Dalewood Ln.
Kings Park, NY 11754

Expanding[2] on the PC

I would like to bring to your attention two omissions regarding Persyst's Time-Spectrum product that appeared in Mark Welch's article "Expanding on the PC" (November 1983, page 168).

In table 14, on page 176, the listing for the Time-Spectrum board does not indicate that a print-spooler package and parallel port are available for the product. Persyst's Time-Spectrum product includes a print-spooler package called "Wait-Less Printing," a RAM-disk simulator program called "Insta-Drive," a clock, one serial port, and one parallel port.

I think your readers would also find Persyst's DCP-88 front-end "soft" communications board to be of great interest. With this product and the communications software available from Persyst, users can support HASP, 3780, and 3270 communications on an IBM PC, PC XT, Columbia desktop and portable, Compaq, and other IBM PC look-alike products.

Ralph Bond
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I note that the article, "Expanding on the PC" did not include the expansion boards of Sritek Inc., which were mentioned in BYTE a few months ago. I wonder if you know something I don't. Because I am considering buying one of Sritek's boards with a 16- or 32-bit processor, and because they are very expensive, I would appreciate it if you could pass on any negative comments you might have heard about these products.

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Mark Welch responds:

Unfortunately, information on some products was not available to me at the time the article was written, and I simply missed other products. The latter was the case for Sritek's Microcards, which were mentioned in Sudha Kavuru's article "Modular Architecture" (June 1983, page 194). As far as I know, the company is producing the boards; a review of the 16032 Microcard is planned for a future issue. Readers interested in Sritek can write to them

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

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

"When the Burlington Area Vocational-Technical Center needed a multi-user system for student training, we considered many multi-user systems, but in demo after demo there was too much of a user delay.

Then IBC contacted us, and offered to demonstrate the Middi Cadet's multi- user capabilities-we were skeptical, but we gave it a try.

First, the Middi Cadet ran 9 users doing word processing without any delays. As a second test, we had the Middi operating 3 terminals each on word processing, accounting and BASIC programming. Again, no user delay. This was the multi-user, multi-tasking system we had been looking for.

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On top of that, we felt that we got a very good price from an excellent vendor. Our system was delivered and installed two weeks later. Since then we've been so pleased with the Middi that we're planning to buy another. With two systems providing 18 stations we will be equipped to offer training in all aspects of information processing."

The Middi Cadet is a 10 user system that includes a 6MHz, Z80B CPU; 256 to 512K Bytes of RAM memory; a 20 MB, 5¼" hard disk drive and a one megabyte 5¼" floppy disk drive.

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FORTRAN-77		✓	✓	✓	TBA
C BASIC Compiler	✓	✓	✓	✓	✓
Pascal/MT+	✓	✓	✓	✓	✓
Level II COBOL	✓	✓	✓	✓	TBA
PL/I	✓	✓	✓	✓	TBA
C		✓	✓	✓	✓
Assembler Plus Tools	✓	✓	✓	✓	TBA
Access Manager	✓	✓	✓	✓	TBA
Display Manager	✓	✓	✓	✓	TBA
micro/SPF		✓	✓	✓	
COBOL Animator	✓	✓	✓	✓	TBA
Personal BASIC		✓			TBA
Dr. Logo		✓	TBA		

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Capital Equipment Corporation's CEC 01000 expansion card also was not included in the listing. This $395 card allows the IBM PC to interface to the IEEE-488 GPIB bus. (Capital Equipment Corp., 10 Evergreen Ave., Burlington, MA 01803, (617) 273-1818.)

Computer Technology Innovations has gone through a number of changes not reflected in the article. The firm changed its name to Univation and no longer produces the ISCDA-0 serial board (page 174) or the IMF-APGC and ISC5A multifunction boards (page 176). In addition, the price for the IC5/8C disk controller (page 172) is now $199, not $175. Univation's new address and phone number are: 1037 North Fair Oaks Ave., Sunnyvale, CA 94089, (408) 745-0180.

More Array Capabilities

"Array Capabilities for dBASE II" by Charles O. Hartman (November 1983, page 552) was a pleasure for me to read. The author presents a clever solution to the problem of programming languages that don't provide convenient array constructs.

There is at least one other way around the problem: namely, to use the vector power inside database-management systems (especially those quoted as relational). This solution offers the gigantic size of a vector defined as a file, but it is relatively slow compared to main memory and uses one file when so few are allowed to be opened simultaneously (two with dBASE).

Paul-Andre Des Jardins
Management Sciences for Health
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Rabat, Morocco

To Err Is Human

Douglas Davidson introduced his "forgotten sort" ("Address Calculation: The Forgotten Sort," November 1983, page 494) in your Technical Forum. He argues that the sort works in time proportional to the number of items to be sorted [0(n)]. On page 498, he states that the "full mathematical treatment (of his claim) is unnecessary." It is indeed unfortunate that he did not attempt the full mathematical treatment. If he had, he might have discovered not only that his algorithm fails to sort in the time he claims, but that, in fact, no sort can work in time less than

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Circle 5 on inquiry card.

n times the log of n [0(n log n)]. A proof of this "forgotten" truth can be found in any introductory text on algorithms (e.g., Horowitz and Sahni: *Fundamentals of Data Structures*, or Knuth: *The Art of Computer Programming*). Furthermore, the method of sorting in question does have a name (hash coding) and is well known. It is not, in any sense of the word, "forgotten" (except perhaps by BYTE and Mr. Davidson).

I can forgive Mr. Davidson for not knowing these facts. He is, after all, still in high school. However, I cannot forgive you, a well-known journal, for publishing such misinformation under the guise of a "technical forum."

Greg W. Scragg
Williams College
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Douglas Davidson replies:

In reply to Mr. Scragg's criticism: I cannot and will not claim that the algorithm presented will require time proportional to n for any possible condition of the input. In fact, I believe that the article clearly states that this algorithm requires a uniform or near-uniform distribution of the keys for efficient operation. With this proviso, it seems to me that the algorithm operates in time proportional to n, and, in any case, that the program presented executes in a time proportional to the value of the variable N; I present in my postscript an argument that may be convincing. These theoretical considerations, however, obscure the main point of the article. Both the placement of the article in an enthusiast magazine and the presentation itself should make it clear that my purpose was to present a practical technique to amateurs like myself who like to write programs but don't like to sit around and watch a bubble sort grind out a hundred elements. The sort presented is, in practical terms, fast; I consider this, rather than any theoretical arguments, to be its ultimate justification. The use of the word "forgotten" is perhaps unwarranted, but it is based on the fact that in several years of reading the literature of hobbyist and personal computing, I have seen many references to slower (bubble, Shell, etc.) and more complex (shuttle, quicksort, etc.) sorts, but none to this particular algorithm. If it is, as Mr. Scragg implies, widely known among computer scientists, then they have not communicated it to us amateurs. To recapitulate: the article presents a fast sorting algorithm for practical use, embodied in a progam that can be seen to operate in time proportional to n; any theoretical carping, even if true—and I submit that it is not—is essentially irrelevant. I apologize for any misunderstanding I may inadvertently have caused.

P.S. It seems reasonable to conclude that the question of linearity rests on the number of passes through lines 160 to 180, as the other portions of the program are fairly straightforward. If the expected number of passes through lines 160 to 180 per list element is not a function of n, then the expected time taken by the program will be proportional to n. But the number of passes through these lines required by an element is purely a local property of the array A%, and so can depend only on the density of nonempty elements in A%; but this density varies from zero to (in this case) 1/2.36 and is not a function of n.

More Worries

I enjoyed the two articles about the new HP 150 personal computer and its development (October 1983, pages 36 and 51). After following this growing industry for the last 11 years, I finally feel that there is a machine on the market that meets my demands.

One comment about the HP touchscreen. Imagine the following situation: you have a disk in the drive holding a file with your bank statements and you are about to update them. A database program that makes heavy use of screen touch keys is up and running. Suddenly, a fly lands on a screen touch key labeled "Delete Record" (something not so impossible in countries with tropical climates). You wave the fly away, causing the function to be activated. Fortunately, the program asks for confirmation of a delete instruction by requiring you to touch a "Confirm" area. The fly, however, is still buzzing around and lands right there. If the fly leaves, the record is deleted; you are now at the mercy of a real bug.

Software that makes use of the touchscreen feature will have to consider rather strange situations.

Miguel Koren O'Brien de Lacy
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The Estridge Interview

It's too bad you had to ruin your magazine with an interview with Philip Estridge ("IBM's Estridge," November 1983, page 88). Two points come out loud and clear:

He can't type or he would have had an IBM Selectric on his desk and would have known where the keys went on the keyboard. (Why didn't he ask his secretary?)

He likes Easywriter! That proves he's a masochist.

Marvin Konopik
American Embassy
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APO San Francisco, CA 96356

I found your interview with Philip Estridge excellent and most of what he said on the mark. But I feel he missed the mark on the IBM PC keyboard. The need to please everyone has, of course, eluded us all, but you can please *somebody*. I do not know *anybody* that likes the PC keyboard. The keys are unreliable, particularly the "-" on all the keyboards I've tried; the keys are too small for large hands; and most people would prefer a different placing of the control keys. Dislike is most intense among professional "key pounders" who routinely work with other keyboard layouts.

My point is that IBM seems to ignore this universal commendation and wave it away with "you can't please everybody." Since the rest of the machine is a good effort, a little more recognition of *everyone's* dislike of the keyboard would be appreciated.

Robert A. Day
628 Nightingale St.
Livermore, CA 94550

Xenix/BASIC Performance

I was most interested in Sam Harp and Marvin Stone's letter (October 1983, page 20) regarding how slowly the Radio Shack Model 16 performed.

It seemed obvious from the results given that the problem is in Xenix or BASIC. To test this, I ran the same program on a 68000 running at 12.5 MHz with one wait state as an attached processor for an Apple II look-alike. My results were 29 seconds, the same as for the IBM PC, rather than the 132 seconds of the Model 16.

Because the 68000 (a Dtack Grande, from Digital Acoustics) was only doing the actual math processing and not interpreting the Applesoft program, the

And it's happening again with our IBM* compatible Rana 2000. This 320k double density drive offers a large centering cone for problem-free diskettes and our exclusive silencing mechanism to make it the quietest disk drive you can buy.

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Popular Computing
October, 1983

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results are much slower than would otherwise be the case. Using the 68000 alone would reduce the time for the benchmark to less than 10 seconds.

Perhaps the problem is an inappropriate use of a high-level language to implement Xenix/BASIC. The obvious result is a crippled system. It is certainly possible to run the 68000 to produce benchmarks two or three times faster than any other personal computer currently on the market. This will become very obvious as soon as someone releases a well-designed BASIC for the Model 16.

Eric Lindsay
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Faulconbridge NSW 2776
Australia

Novices and the Morrow

As the owner of a Morrow MD-3, I must take issue with Tom Wadlow's views regarding the purchase of this computer by novice users ("The Morrow Micro Decision," October 1983, page 306). The author's contention that the software is not suitable for novice users creates the impression that the beginner would have a great deal of difficulty using the software.

I am a relative novice to computers, with only minimal experience using an Atari 400 with cassette interface, and (was) a complete novice in the use of floppy disks for software application. With total time on my system now at perhaps 40 hours, I feel that all of the software is accessible to and usable by me, with the exception of the uninstalled (read unlicensed) Quest Accounting software.

The Morrow Pilot software took the confusion out of making backups for the operational software and allowed installation of CP/M on all of the working disks without any problems whatsoever. I merely followed the directions in the Morrow documentation and the menus presented themselves on the screen. The documentation for Logicalc admittedly does not have much in the way of a tutorial; however, this menu-driven spreadsheet is much faster to learn than Supercalc (I was shown this subsequent to my exposure to Logicalc), despite Supercalc's rather extensive tutorial. Supercalc is perhaps a more powerful program, but for the occasional user, Logicalc has my vote for being user-friendly.

Circle 398 on inquiry card. →

Circle 388 on inquiry card.

Letters

As far as the terminal goes, most dealers I spoke with echoed the author's concerns that the Lear-Siegler terminal is very poor; each of them recommended the Freedom terminal, which appears to overcome all of the inherent problems of the Lear-Siegler.

I researched the midrange computer market for almost six months before purchasing the Morrow and I became convinced that this computer offered the most value and highest quality within this price range. My use of the computer in the past weeks has shown it to be everything I expected. It would be a shame for novice users to be scared away from such a fine product strictly because of the lack of a tuturial in two of the software packages.

Steven D. Edgett
541 Shasta Way
Mill Valley, CA 94941

Buyers Count Dollars

In the interview with the Macintosh design team (February, page 58), Steve Jobs appears to be hung up on the IBM video-board chip count. Great; as an engineer, I, too, appreciate an elegant design. Unfortunately, the Macintosh design elegance does not seem to be reflected in its price tag. It remains to be seen whether the mouseketeers of Bandly Drive have a winner or are once again a day late and a dollar long.

Steve is quoted as saying of the IBM video card, " . . . it basically does nothing. And it doesn't even do that very well." Wrong, Steve, it does something very well—it sells like hotcakes.

The bottom line is that engineers and hackers count chips but buyers count dollars, the number of available programs, and quality of support. At $1500, the Macintosh could have been named the Volkslisa, but at $2500—ho hum. With all the choices, I think I'll just shop around.

Joseph N. Mente
Federal Signal Corp.
2645 Federal Signal Dr.
University Park, IL 60466

On Fixing Things

After reading Tim Field's article "The IBM PC and the Intel 8087 Coprocessor, Part 2: Interfacing to IBM Pascal" (September 1983, page 331) about using the 8087 in the IBM PC, I must ask, what is going on at IBM and Microsoft? Why must Mr. Field and all those who follow his apparently comprehensive instructions have to do so at all?

Is it so difficult for Microsoft, the self-proclaimed "standard," to add an 8087 library to its compiler? Years ago North Star obtained excellent performance by using a math chip. Digital Research provides 8087 libraries with Pascal MT+.

Why would anyone want to add FORTH-like routines to do arithmetic? Why doesn't IBM put some time and effort into providing a decent compiler for its hardware?

While I can understand Mr. Field's need to use two real storage units to store one real number, I pity the programmer who has to modify the code later.

It is as important that BYTE comment about incomplete products (such as IBM Pascal) as it is for BYTE to indicate how to get around the associated problems.

Mike Draper
Raxco Ltd.
18 Cowdy St.
Kingston, Ontario
Canada K7K 3V7

Microcomputer Study

At the Public Management Institute (PMI) of George Mason University, we are beginning a study on the use of microcomputers in the public sector. The purpose of our study is to establish basic information on both the uses to which micros are put in the public sector and management approaches to dealing with the introduction of micros in government offices.

If any of your readers have had experiences planning for, using, or managing microcomputers in a public-sector environment (excluding educational institutions), we would like to hear from them. All information provided will be kept in strict confidence and contributors will receive a copy of the study report. We may be contacted at the following address:

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4400 University Dr.
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the experiences gathered for this study to establish a national information-sharing network for public-sector institutions that will enable public agencies to secure information and assistance with the task of microcomputer implementation.

John W. Ostrowski
George Mason University
Fairfax, VA 22030

Turbocharging

The January 1983 issue has a nice listing of benchmark timing figures for the Sieve of Eratosthenes program ("Eratosthenes Revisited: Once More through the Sieve," page 283, by Jim and Gary Gilbreath). Having recently brought up an 8-MHz Slicer computer (using the 80186) running CP/M-86 and a just-acquired copy of Borland's Turbo Pascal, I thought the time had come to do an experiment. I was somewhat staggered by the results:

Load Turbo from 8-inch single-sided, single-density disk: 12 seconds
Load Sieve into Turbo: < 1 second
Compile into Com file ready to run: 0.1 second!
Execute 10 iterations: 6.2 seconds
Bytes of code compiled: 288
Bytes of data: 8208
Bytes of stack/heap: 62176

The compile time seems to be some 300 times faster than the next fastest shown in table 3 in the article. The test/demo program that comes with Turbo Pascal contains 1200 lines of Pascal programming and compiles in 12 seconds into a Com file on this machine.

Edward S. Dayhoff
1618 Tilton Dr.
Silver Spring, MD 20902

The Ultimate Test

The feedback we've received from our article "An Operations Research Scheduling Program" (September 1983, page 549) was gratifying, more so perhaps because BYTE readers actually were applying the program therein to real problems.

However, precisely because other problems were attacked, several fatal bugs were uncovered by readers. The main bug, giving a "NEXT WITHOUT FOR ERROR" at line 3760, involved several logic errors; this problem may be patched by the following changes:

```
3620 GOSUB 4910: REM – FILTER
3730 IF FLAG = 0 THEN GOTO 3750
4720 IF RPT=1 THEN HOME:PRINT:
     PRINT "A GOOD SEQUENCE
     IS:":GOTO 4770
```

Additionally, you must DELete lines 3890 through 3940, and in lines 4340, 4370, and 4390, change the variable FL to FG. These changes should make the program run correctly.

Walter A. Stark Jr.
POB 372
Los Alamos, NM 03449■

BYTE's Bits

Unique Dolphin Program

A program from Syntauri works with an Apple II/IIe and Mountain Computer's Music System to produce dolphin-like sounds. Dolphin Dialogue is used by a communications project at the Institute for Delphinid Research. Researchers there use this software to investigate language-like communications with dolphins.

The researchers synthesize sounds similar to a dolphin's distinctive whistles and trills. Program operation is simple: a sequence of letters entered via the keyboard triggers dolphin-like noises that are used to make a simple sentence that both man and dolphin can interpret. The dolphins are said to have learned words and to have achieved a limited understanding of word combinations. Communication is now one-way. Future plans call for an underwater link between the dolphins and the computer to let the dolphins produce their own combinations of words.

All profits will be donated to the Cetuman Foundation, which funds the Institute. The program costs $39; $44 overseas. A poster is $10. Syntauri Corporation is located at 4962 El Camino Real, Los Altos, CA 94022, (415) 966-1273.■

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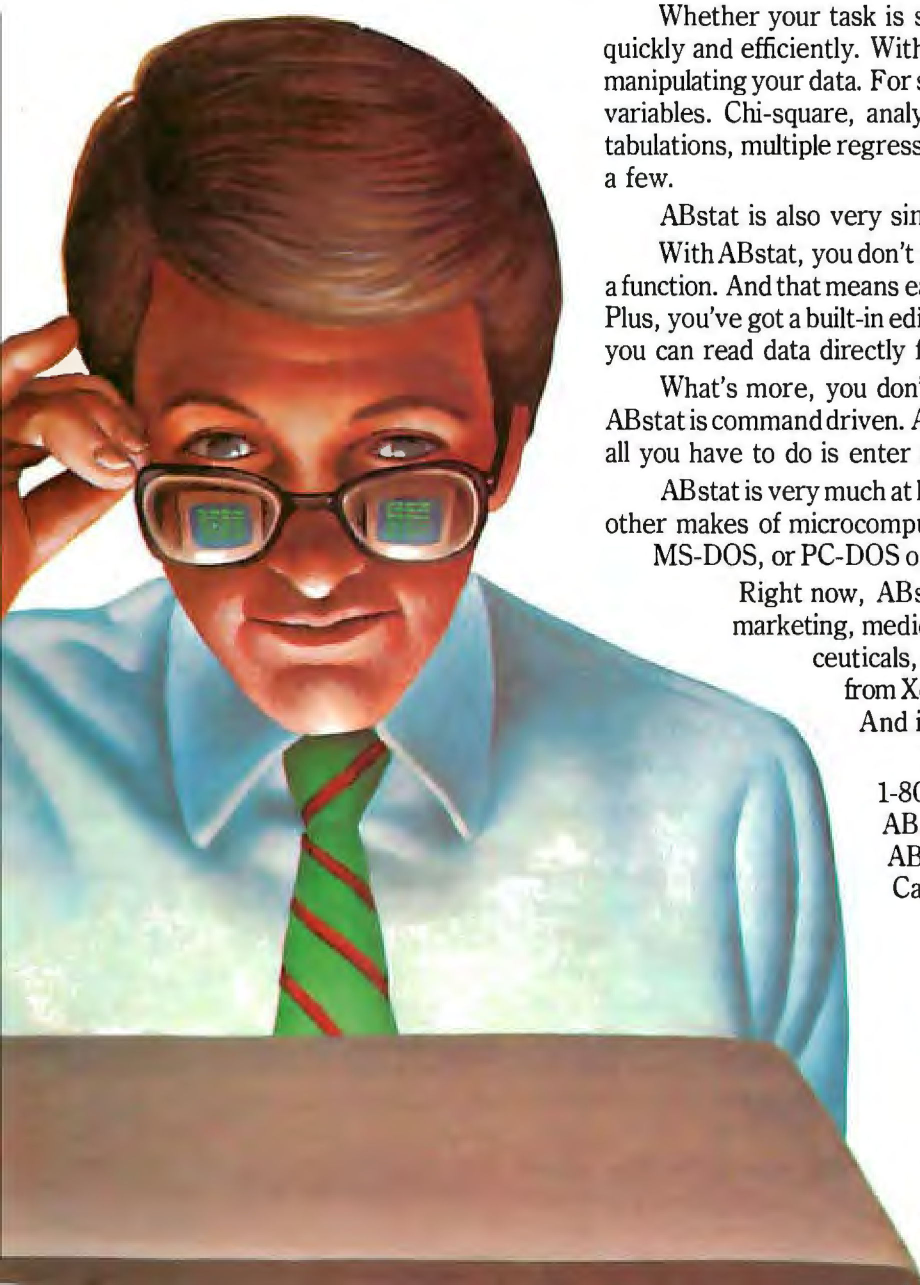

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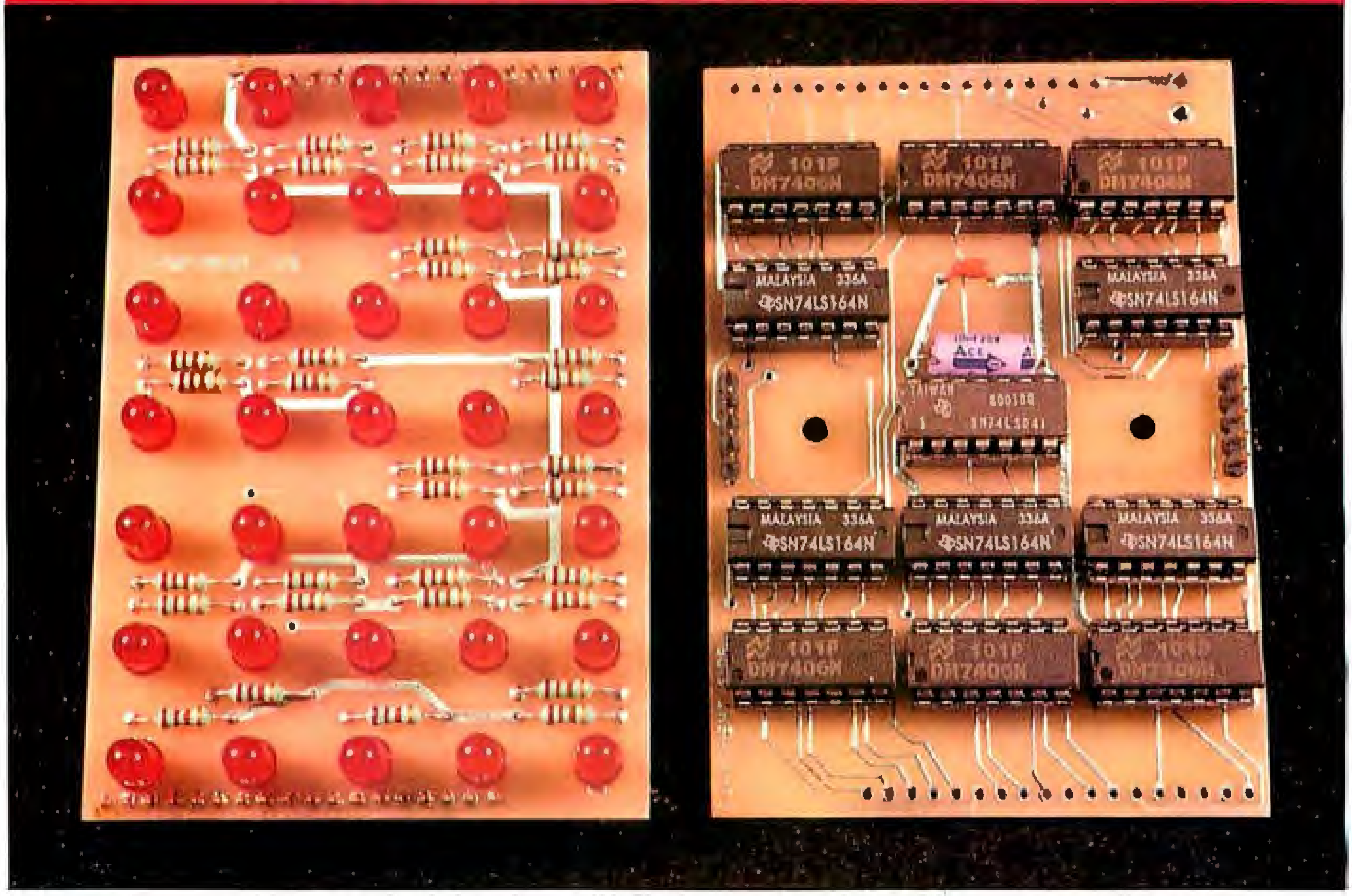


Photo 1: *The two printed-circuit boards needed to form one character segment in the display. One board contains the 35 LEDs and the current-limiting resistors; the other holds the shift-register sections and buffer/drivers.*

Build a Scrolling Alphanumeric LED Display

Individual character arrays can be linked together to show longer messages

Steve Ciarcia
Consulting Editor

The helicopter banked around, and someone gasped audibly as we beheld the spectacle of the Grand Canyon. The computer-show exhibitor who had sponsored this special excursion for our group was getting his money's worth. But my thoughts, dulled by visits to seven hotel hospitality suites, strayed from the scenery to another computer show. . . .

In Atlantic City in the sleepy pre-casino year of 1977, I had wandered the aisles of Personal Computing '77, the second such event organized by John Dilks. Dozens of garage-based entrepreneurs were showing off their answers to the MITS Altair 8800 in display booths that mostly contained prototypes propped up on card tables. I was looking for new ideas that might help me in my work as a full-time engineering consultant or might inspire me to write a second article for Carl Helmers, who was editing a new magazine called BYTE. It would still be many months before he would suggest that I write regularly.

That early convention contained none of the hype and high-tech glossiness of today's extravaganzas. The idea of setting up a lavish hospitality suite or of renting Disneyland for a night hadn't yet occurred to any microcomputer companies, none of which had hired image-conscious advertising executives.

But technical ideas came thick and furious in those days, I mused. Although a few clever inventors had used their inspirations to vault into prosperity, some ideas I had seen weren't the kind on which fortunes are built. Like the guy I had talked to that year who was convinced that his hand-soldered scrolling LED (light-emitting diode) display would make him a millionaire. . . .

Wait a minute! Maybe it did. Just yesterday I had seen scads of scrolling LED display signs in the exhibit hall. These signs, which are generally designed as a single message line 10 to 20 characters long, consist of a multitude of LEDs that are wired in such a way that the text scrolls in sequence from right to left.

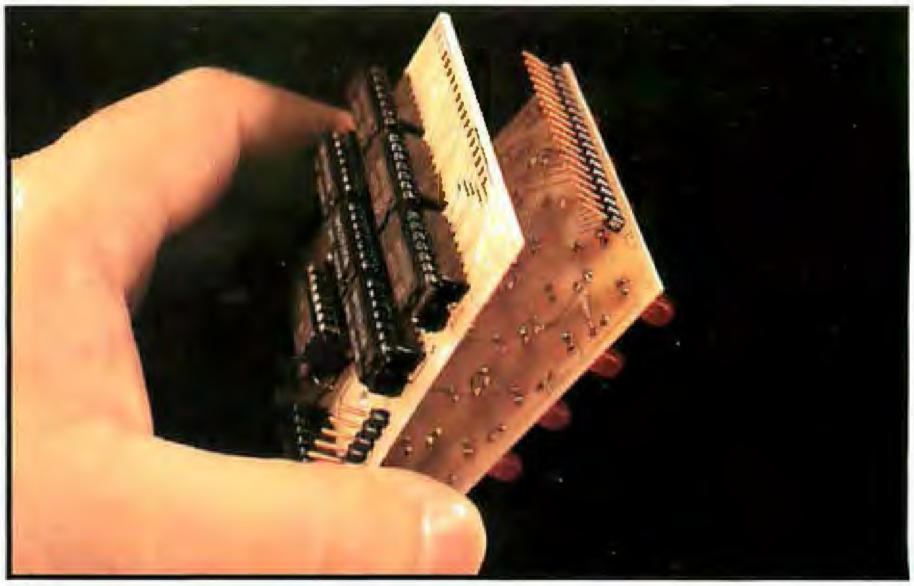
I had stopped at one company's booth to admire its LED display. The LED unit consisted of twenty 5- by 7-element dot-matrix characters and a hand-held controller that allowed you to enter messages that would be displayed on the sign. It came housed in an attractive wooden enclosure with a power supply. The price was $2000, and the exhibitor was doing land-office business—if I wanted one, I'd have to wait three months. Two aisles away the real pièce de résistance resided: at the Hewlett-Packard booth was a 4- by 5-foot LED graphics display (not for sale). The LEDs in the character segments were spaced so that the characters could be expanded both horizontally and vertically. I had inspected HP's display and estimated that there were approximately 10,700 LEDs in it.

The helicopter pitched, and my thoughts were jerked back to the present. But my next project was decided. I wanted a scrolling LED sign for the Circuit Cellar.

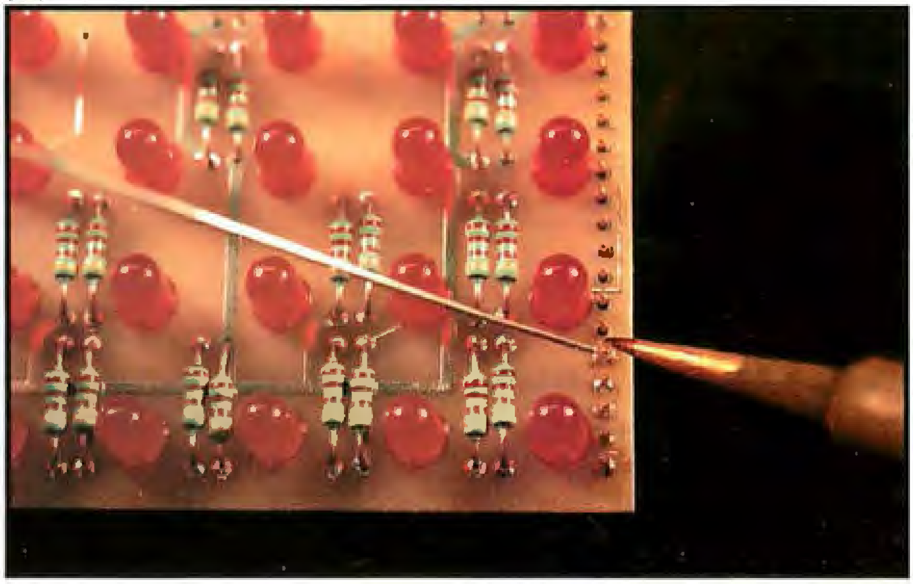
Design Alternatives

You don't have to have an engineering degree to design a scrolling LED display. But when a project contains so many components, it's best to

(2a)



(2b)



(2c)

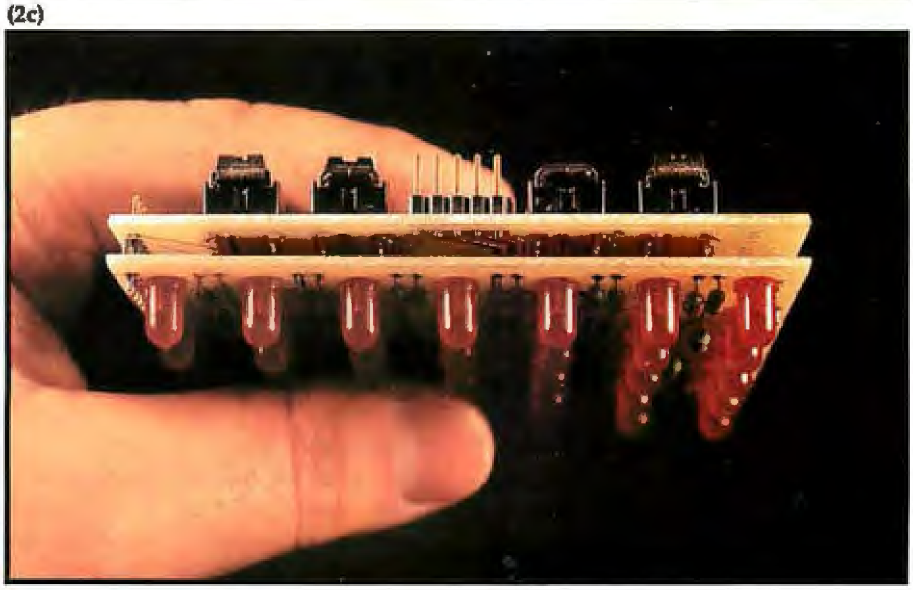


Photo 2: *The two boards are mounted back to back (2a). Two 18-pin Berg-type connectors are soldered together (2b) to electrically and mechanically join the two halves into a sandwich (2c). The 35 LEDs in the character segment are placed on half-inch centers in both dimensions for possible use in graphics.*

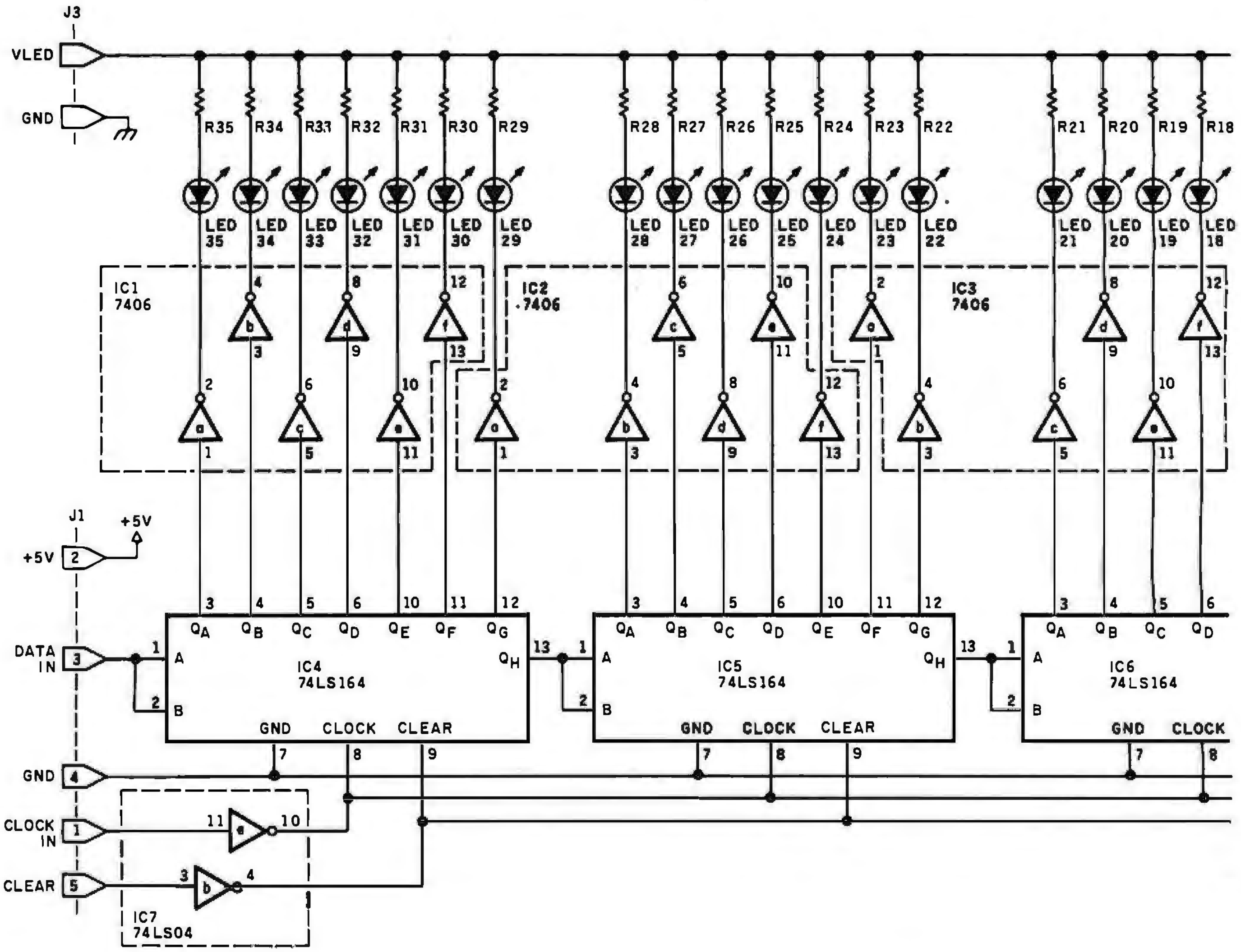


Figure 1: *Schematic diagram of one of the character-segment subassemblies for the scrolling LED display.*

spend some time early in the design process considering how to keep the final product easy to make and use.

When I looked at that first LED sign seven years ago, I thought, "What a simple product! How hard is it to drive a few LEDs?" But now that I was close to building a sign, I noticed the roadblock that had kept other people from doing the same: there are a *lot* of LEDs in it.

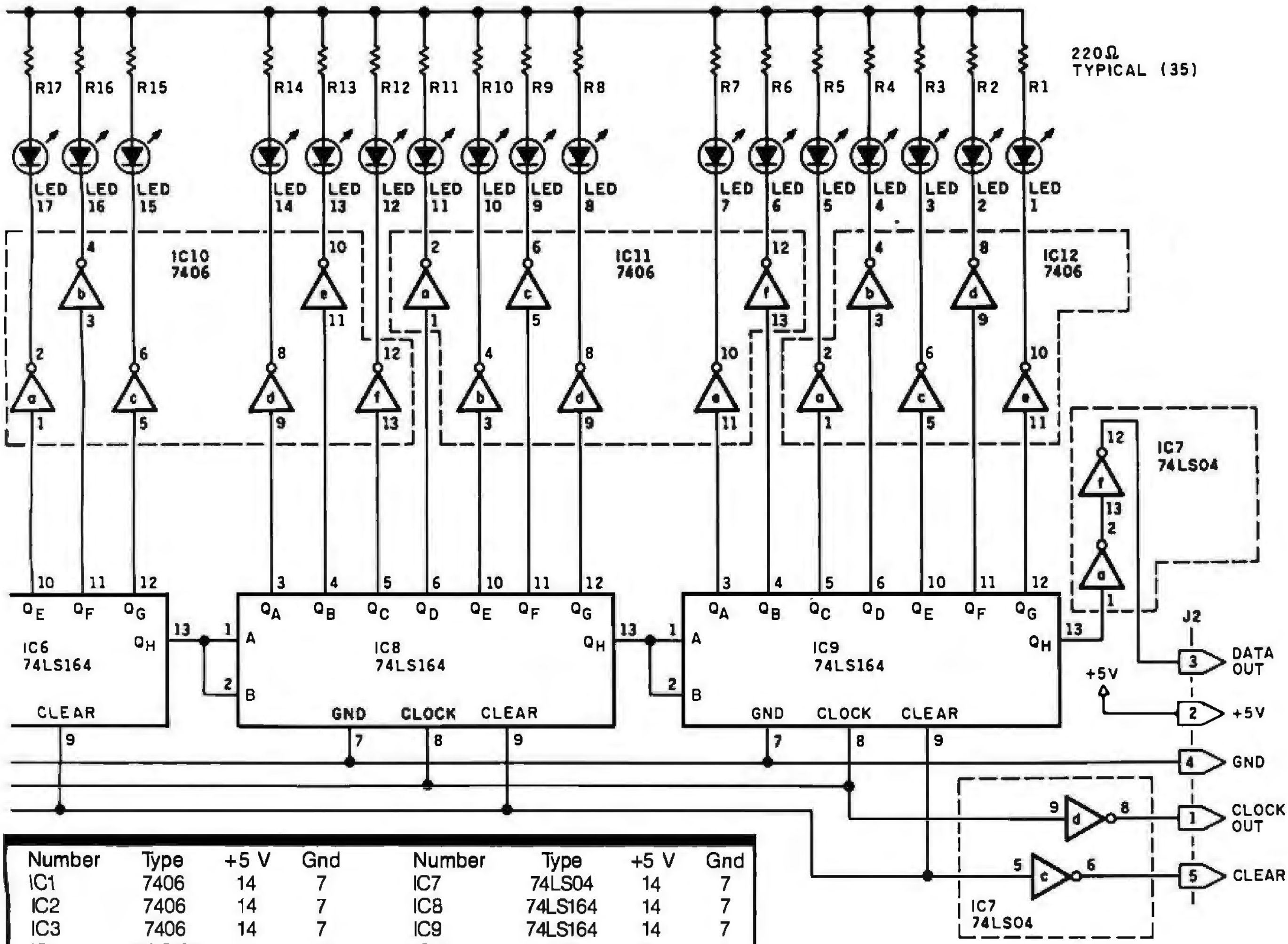
The most direct approach to controlling all those LEDs is *direct drive*, in which a wire for each individual LED is connected to one line of a parallel output port. When the appropriate bit in the output port is turned on, the LED connected to it (through an LED-driver component) will light up. A typical direct-drive setup requires little sophistication, but it takes a lot of hardware. Controlling 100 LEDs requires 100 separate output lines and drivers.

The best alternative to direct drive is the *multiplexed* display. In this arrangement, the LEDs are wired at the intersections of a series of rows and columns. Each LED is illuminated when voltages appear on both its row connection and its column connection and current flows through it. Component count is thus reduced because only a single set of row and column drivers is required. Unfortunately, figuring out the proper scanning speed, the peak power dissipation, and the average intensity makes designing the control circuit relatively complicated. A few years ago I worked through a multiplexed display design and wrote an article entitled "Self-Refreshing LED Graphics Display" (see reference 2), which you can read if you want to know more on that topic.

The LED display I built for this article had to be simple enough to be wired by hand (by someone with time to spare) and yet also be sufficiently sophisticated to duplicate the intelligent features of commercial units. I decided to use a version of the direct-drive technique.

Design Specifics

Each character segment must consist of at least 35 LEDs (for a 5 by 7 matrix) to display a complete set of alphanumeric characters, even for a single-line display. A 6 by 9 matrix would need 54 LEDs. The support circuitry—drivers, current-limiting



Number	Type	+5 V	Gnd	Number	Type	+5 V	Gnd
IC1	7406	14	7	IC7	74LS04	14	7
IC2	7406	14	7	IC8	74LS164	14	7
IC3	7406	14	7	IC9	74LS164	14	7
IC4	74LS164	14	7	IC10	7406	14	7
IC5	74LS164	14	7	IC11	7406	14	7
IC6	74LS164	14	7	IC12	7406	14	7

resistors, etc.—necessitates hundreds of connections for each segment. While I considered wiring one segment by hand, I didn't have the time to construct two, let alone 20. Even though an LED sign is relatively uncomplicated, the sheer number of connections makes it hard to put together. I definitely needed to display between 10 and 20 characters for most applications, so I decided to lay out a printed-circuit board even before building my first prototype. (I don't recommend this shortcut to anyone who doesn't possess years of experience with digital electronics.)

The configuration I came up with for a character segment, shown in photos 1 and 2, is an amalgam of two printed-circuit boards mounted back to back. The front board contains 35 LEDs and their current-limiting resistors, while the rear board contains 12 integrated circuits (the shift registers and drivers); all these parts form a 5- by 7-element character matrix. Segments are linked together in daisy-chain fashion to build linear arrays of many characters, as shown in photo 3. And while a single-line textual display is the most probable application, the LEDs are spaced on half-inch centers both horizontally and vertically so that graphics images can be displayed.

Instead of using conventional parallel direct-drive activation, I put in a serial shift register, effectively 35 bits long, to control the 35 LEDs. As a bit of data is shifted through the register, the LED to which it corresponds is illuminated or extinguished depending upon the bit's logic level, high or low.

Figure 1 is a schematic diagram of one of the character-segment subassemblies; figure 2 shows how the LEDs are placed to form the matrix. A serial shift register, physically 40 bits in length, is formed by IC4, IC5, IC6, IC8, and IC9: five type-74LS164 8-bit registers. The first seven positions in each of these chips (0 through 6) are connected to LEDs through the open-collector driver sections of IC1, IC2, and IC3 (type-7406 inverting buffer/drivers); the eighth position (bit 7) is not connected to an LED but is reserved for connecting adjacent register stages.

Data is entered into the shift register one bit at a time by setting the appropriate logic level for the bit

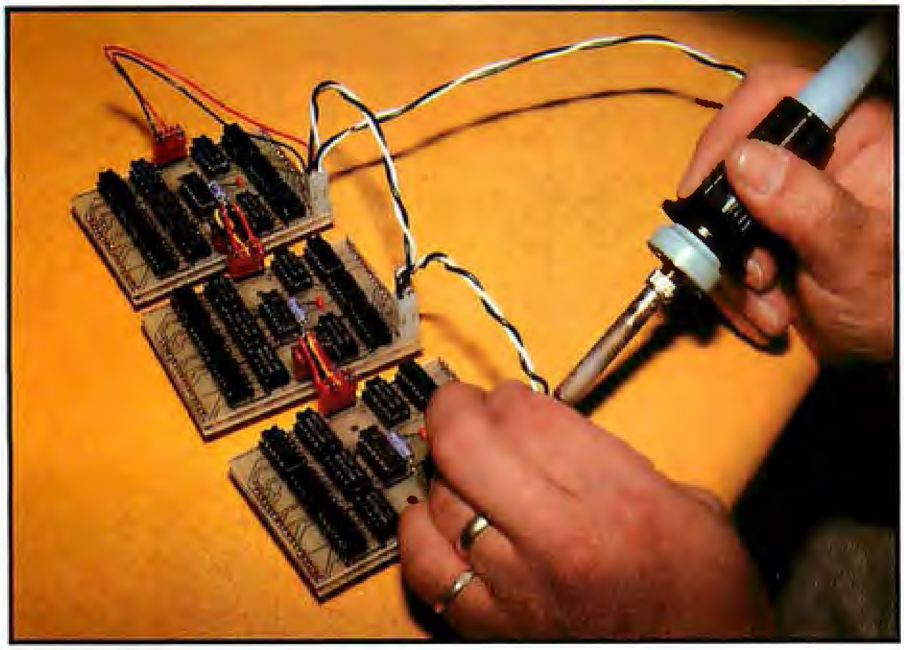


Photo 3: *Multiple character segments are connected together in a daisy chain to form a linear display capable of holding several words at once. The red connectors at the center of the board edges carry the CLOCK and DATA signals, while the black and white wires carry the power to drive the LEDs.*

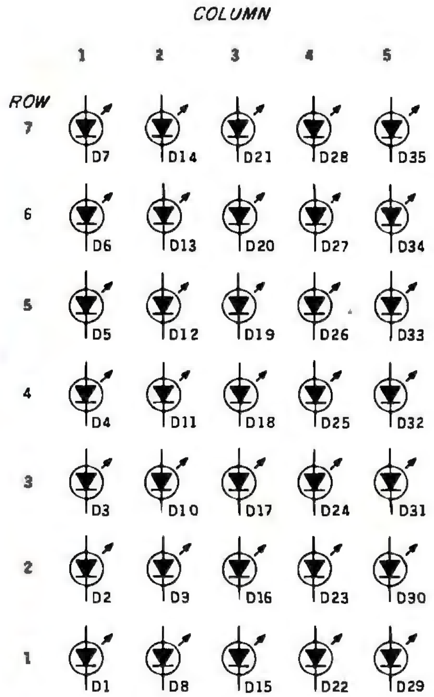


Figure 2: *The LEDs are placed to form a 5-by 7-element matrix.*

on the data input line and then pulsing the clock input line to a logic 0. Data is synchronously shifted through the register on the occurrence of the negative-going edge of the clock pulse, with the result that the light pattern on the LED matrix also shifts. To clear the display, a high level is set on the CLEAR line, which normally operates at a logic 0 level.

As figure 3 shows, the bits enter the rightmost column of the display (column 5), filling it from top to bottom. Once column 5 is filled, additional data entering the register causes the contents of column 5 to be shifted into column 4, again starting from the top. In essence, data enters the segment matrix from element D35, progressing through to D1.

Although 35 LEDs are in the display, it takes 40 clock pulses to fill the five 8-bit shift-register stages. Each 7-bit word of column data is preceded by a filler bit (usually a 0) that does not show up in the display. After eight clock pulses have occurred, the

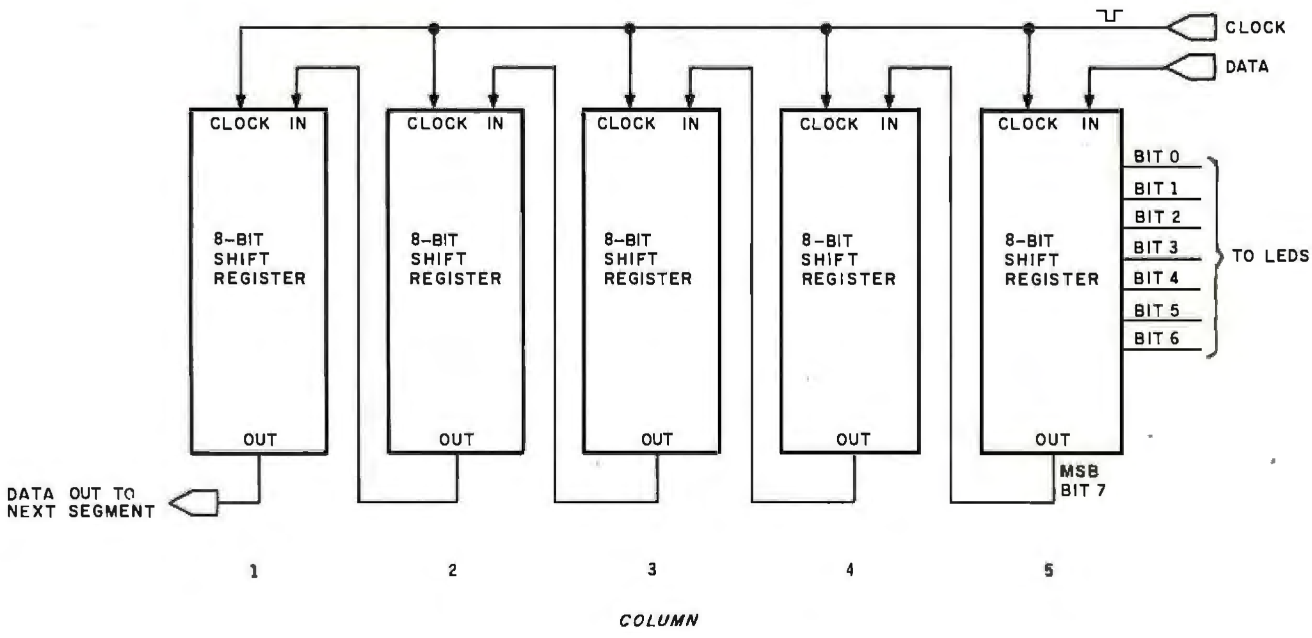


Figure 3: *The shift-register sections are wired so that bits being shifted out of the rightmost column (at the most significant bit) enter the next column, and so on to the end of the character segment. Each low-order register position is connected to an LED driver. (Bits can also be shifted from one segment to another.)*

7 data bits will be displayed in LEDs D29 through D35. After 8 more bits have been shifted in, the contents of column 5 have been completely moved to column 4, and so on. (To eliminate confusion, it is best to think of this as a column display where data is always entered 8 bits at a time.)

The shifting takes place too fast to see, so if the display contents are to be viewed by human eyes, the shifting must be halted occasionally for a viewing interval. If the 8 data bits are shifted in quickly relative to the amount of time they are left stationary for viewing, all the display contents will appear to scroll smoothly from right to left, one column at a time. How smoothly the display scrolls depends mostly on the speed of the program controlling it.

How to Use the Display

The Circuit Cellar LED display is simple to use. Because of its serial input, it requires use of only a single output bit from a computer. It's convenient to use one bit of a conventional parallel printer port as a source for this signal; figure 4 shows how the printer port on an IBM Personal Computer's Monochrome Display Adapter can be wired to the LED display. Another benefit arises because of this arrangement: when a bit is output through the printer port, the port's 5-microsecond (μs) STROBE signal is automatically triggered. These STROBE signals can be used as clock pulses to shift the bits through the registers. (I used only the least significant bit, bit 0 or the LSB, of the 8 available, but a second data line could have been connected to the display's CLEAR line to control that as well.) If multiple character segments are used, the data input of the first segment is connected to the computer; the other segment inputs are chained from the leftmost column of the preceding segments.

Once you're set up to send bits into the display, you need to know what bits to send. For textual displays, the bits should be set according to matrix patterns that form alphanumeric characters, such as the pattern of figure 5 that forms the numeral "2"

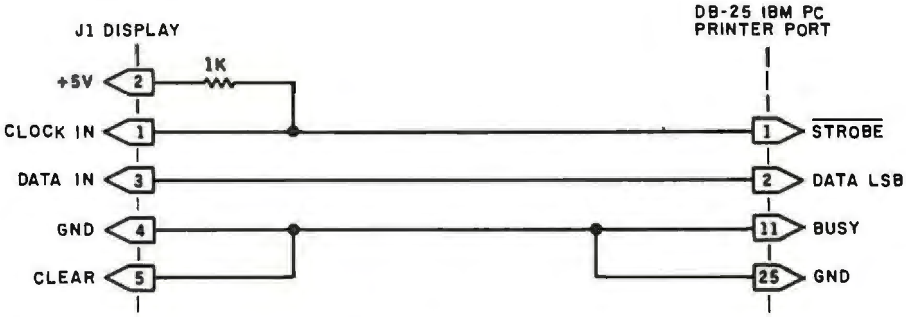


Figure 4: *The parallel printer port on an IBM PC's Monochrome Display Adapter can be wired to drive the LED display using only the least significant data bit.*

Listing 1: *BASIC program that causes a "4" to appear on the scrolling LED display, sending data through a parallel printer port on the IBM PC. If you turn the page sideways, you can see the image pattern in the DATA values.*

```
100 DIM X(50)
110 DATA 0,0,1,1,0,0,0,0
120 DATA 0,0,1,0,1,0,0,0
130 DATA 0,0,1,0,0,1,0,0
140 DATA 1,1,1,1,1,1,1,1
150 DATA 0,0,1,0,0,0,0,0
200 FOR C=1 TO 40
220 READ X(C)
240 NEXT C
250 FOR C=1 TO 40
260 LPRINT CHR$(36+X(C));
270 NEXT C
999 END
```

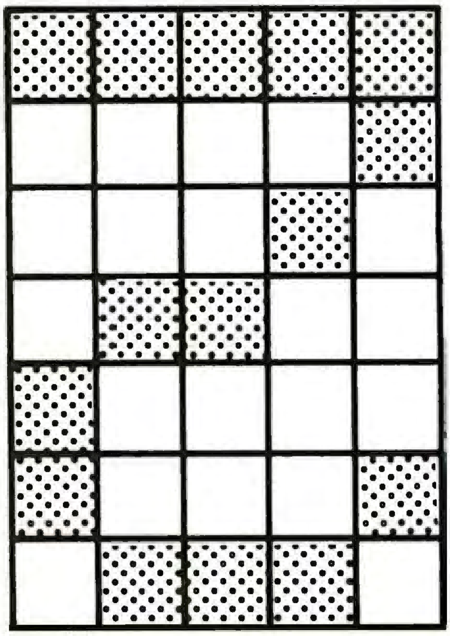


Figure 5: *A bit pattern that forms the numeral "2" in a 5- by 7-element representation.*

Photo 4: *These examples of the numeral "4" were produced by the same bit pattern used in listing 1, but under the control of the Z8-BASIC System Controller. The red plastic filter over the left segment greatly improves the appearance of the display.*

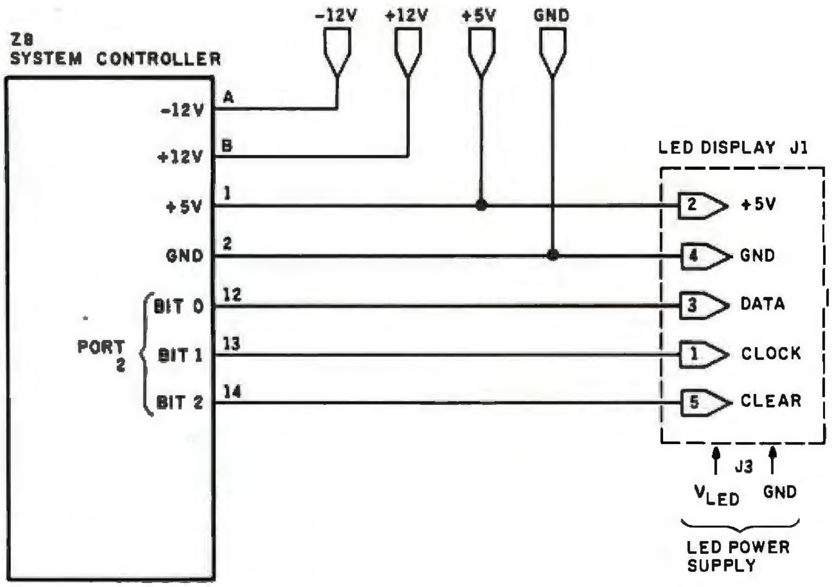


Figure 6: *Diagram for connecting the scrolling LED display to the Z8-BASIC System Controller.*

in a 5 by 7 representation. In the most simple case, data can be sent to the display using LPRINT statements from a BASIC interpreter.

A short BASIC program that displays "4" on the LEDs is shown in listing 1. The program begins with DATA statements that contain the bit patterns for each of the five columns. These values of 0 or 1 are read into the array X in lines 200, 220, and 240. The second FOR. . .NEXT loop sends the data to the display one bit at a time with an LPRINT statement. The expression CHR$(36+X(C)) includes an offset value of 36, which does not affect the LSB but avoids the unpredictability of sending values in the control-code range. If the value of the current element of the X array is 0, the output value of decimal 36 ("$") is emitted at the output port. If the X value is 1, a 37 ("%") is emitted. If a 36 is sent, the LSB is 0, a value that causes its corresponding LED to be darkened as the bit is shifted through the display. If a 37 is sent, the LSB is a logic 1, and the LED will be lit. Two examples of a displayed "4" appear in photo 4.

This is admittedly a rudimentary way to drive the display. But the method is quite effective if you don't mind taking time to code the program. It allows use of the scrolling LED display in a very flexible and economical manner, using the power of your existing computer system.

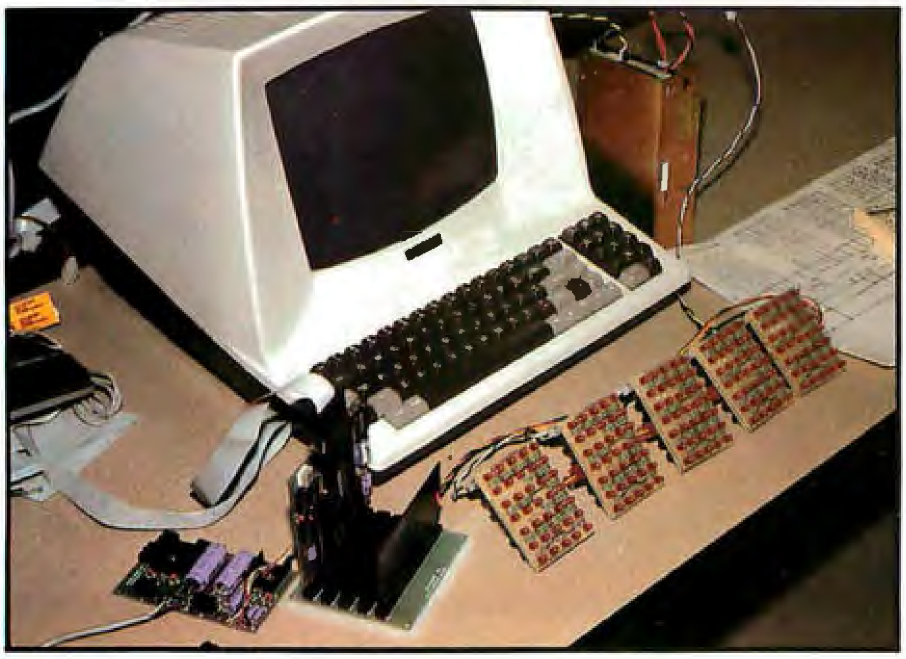


Photo 5: *In my first attempt, several display segments were attached to the Z8 board; the message content of the display can be changed interactively from the video terminal.*

Control by a Dedicated Processor

While you can tie the scrolling LED display to your main computer, as we have seen, using the display is much less trouble if a small, dedicated control processor running custom software is used. I decided to drive my display with a Z8-BASIC System Controller, the successor to the Z8-BASIC Control Computer I developed almost three years ago (see reference 1). Based on the Zilog Z8 self-contained microprocessor, this small computer is well suited for jobs like this. It has an on-board tiny-BASIC interpreter, space for 2K bytes of RAM (random-access read/write memory) and 4K bytes of EPROM (erasable programmable read-only memory), an RS-232C serial port, two parallel output ports, and one parallel input port.

The LED display is attached to one of the parallel output ports on the Z8 board, as shown in figure 6 and photo 5. The message-storage space can hold 256 characters using the unexpanded Z8 board. With the addition of one or more memory-expansion boards, messages up to 50,000 characters long can be stored.

The Z8 board can be programmed to provide several intelligent display features using a combination of tiny-BASIC statements, shown in listing 2, and assembly-language subroutines, shown in listing 3. (A flowchart of the controller software is shown in figure 7.) The software, which is modular in design, uses a table for storage of the character-display bit patterns. Shown in figure 8, these patterns can be easily modified to allow special characters to be displayed. Finally, listing 4 is a sample run of the controller software with the external-terminal mode selected.

You'll need to have a video-display

Text continued on page 52

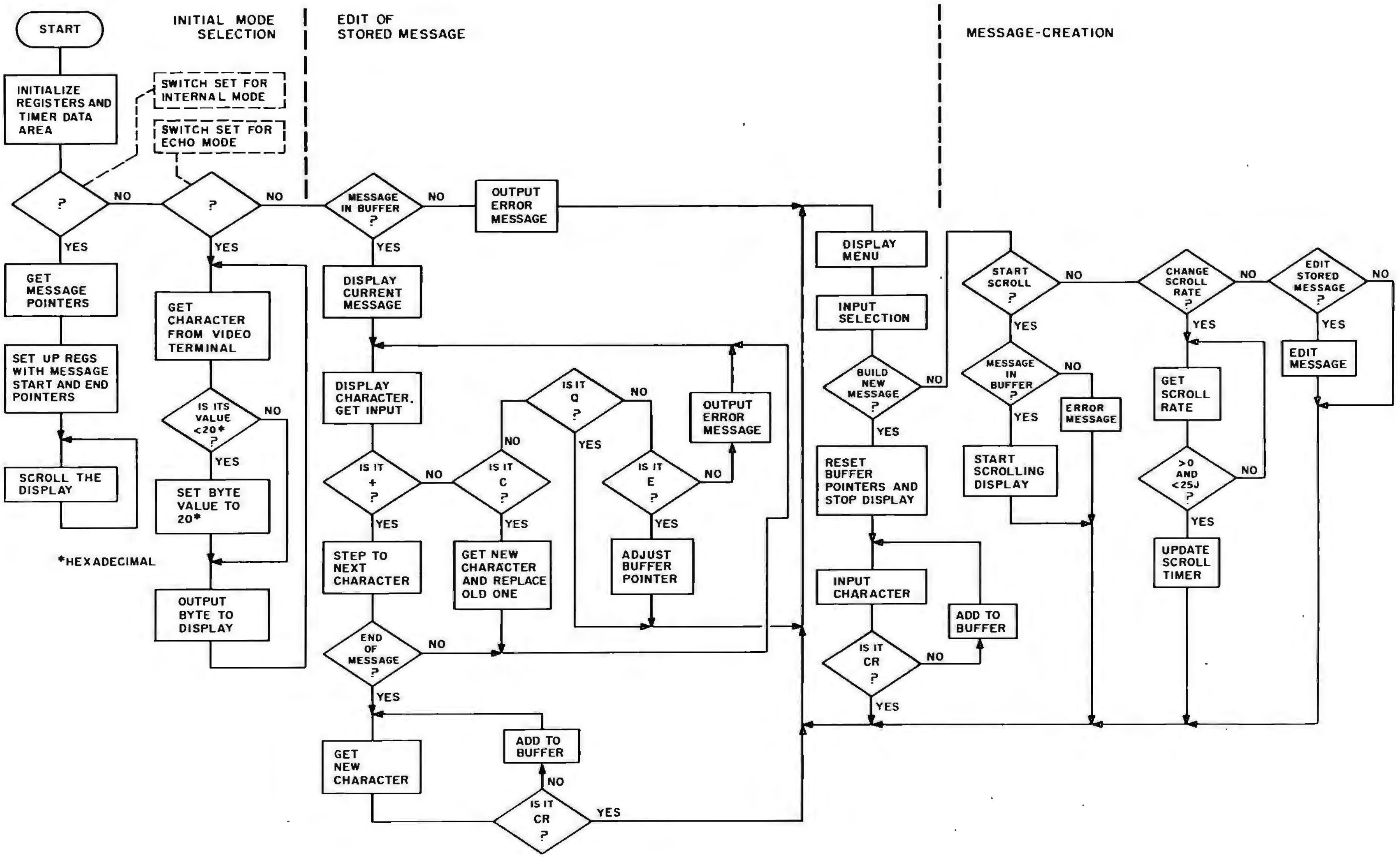


Figure 7: *Flowchart of the display-controller software for the Z8-BASIC System Controller. Some modes of operation are selected by DIP-switch settings on the Z8 board.*

Listing 2: *BASIC program written for the Z8-BASIC System Controller to control the scrolling LED display. Some actions are controlled by machine-language subroutines called by BASIC.*

```
10 GO @%1900
15 B=%0810:E=%080F
20 REM IF I GOT HERE, EXTERNAL MODE IS SELECTED
30 @%F4=%40
40 IF AND(@%FFFD,2)=0 THEN GOTO 10000
50 REM BUILD MESSAGE MENU
60 PRINT
70 PRINT "CREATE A DISPLAY MENU"
80 PRINT:PRINT "1 - BUILD A NEW MESSAGE"
90 PRINT "2 - START MESSAGE SCROLLING"
100 PRINT "3 - CHANGE SCROLL RATE OF DISPLAY"
110 PRINT "4 - EDIT THE STORED MESSAGE"
140 PRINT:INPUT A
150 IF A<1 THEN 50
160 IF A>4 THEN 50
170 GOSUB A*1000
180 GOTO 50
1000 REM ENTER NEW DATA FOR DISPLAY
1010 B=%0810:E=%080F
1015 GO @%1900
1020 PRINT "ENTER DISPLAY CHARACTORS. END WITH RETURN OR ENTER KEY"
1030 X=USR(%54)
1040 IF X=13 THEN 1070
1050 E=E+1:@E=X
1060 GOTO 1030
1070 RETURN
2000 REM START MESSAGE SCROLLING ON DISPLAY
2010 IF E<>%080F THEN 2040
2020 PRINT "NO MESSAGE IN BUFFER - DISPLAY NOT STARTED"
2030 RETURN
2040 ^%38=%0810
2050 @%0801=%08:@%0802=%10
2060 ^%3A=E
2070 GO @%198E
2080 RETURN
3000 REM CHANGE SCROLL RATE
3010 PRINT "ENTER NEW SCROLL RATE"
3020 INPUT A
3030 IF A<1 THEN 3010
3040 IF A>255 THEN 3010
3050 X=USR(%1A76,A)
3060 RETURN
4000 REM EDIT THE STORED MESSAGE
4010 GO @%1900
4020 IF E<>%080F THEN 4050
4030 PRINT "NO MESSAGE IN BUFFER - EDIT NOT POSSIBLE"
4040 RETURN
4050 PRINT "LISTING OF CURRENT MESSAGE"
4060 X=B
4070 C=@X:GO @%61,C
4080 X=X+1
4090 IF X>E THEN 4110
4100 GOTO 4070
4110 X=B
4120 PRINT:PRINT
4130 PRINT "AS EACH CHARACTOR IS DISPLAYED, ENTER + TO SKIP,C TO CHANGE"
4135 PRINT "TYPE Q TO QUIT LEAVING REST OF MESSAGE."
4137 PRINT "TYPE E TO QUIT ENDING MESSAGE AT THIS CHARACTOR"
4140 GO @%61,@X
4150 PRINT " ? ";
4160 C=USR(%54)
4165 PRINT
4170 IF C=%2B THEN X=X+1:GOTO 4220
4180 IF C=%51 THEN RETURN
4190 IF C=%45 THEN E=X:RETURN
4200 IF C<>%43 THEN PRINT "PLEASE TYPE +,C,Q, OR E":GOTO 4140
4205 PRINT "NEW CHARACTOR ? ";
4207 C=USR(%54):@X=C:PRINT:GOTO 4140
4210 PRINT "NEW CHARACTOR ? ";:C=USR(%54):@X=C:GOTO 4140
4220 IF X<=E THEN 4140
4230 PRINT "END OF ORIGINAL MESSAGE "
4240 PRINT "TYPE ADDITIONAL CHARACTORS AND END WITH RETURN OR ENTER"
4250 C=USR(%54)
4260 IF C=13 THEN RETURN
4270 E=E+1:@E=C
4280 GOTO 4250
10000 REM ECHO MODE
10010 @%38=%08
10020 @%39=%10
10030 X=USR(%54)
10035 IF X<%20 THEN X=%20
10040 @%0810=X
10050 GO @%1A12
10060 GOTO 10030
```

Listing 3: *Assembly-language listing of the machine-language subroutines needed to control the LED display.*

```
1900          0010 ;
1900          0020 ;  Z-8 LED DISPLAY DRIVER PROGRAM
1900          0030 ;  FOR THE Z-8 SYSTEM CONTROLLER ONLY
1900          0040 ;  VERSION 1.1 12/31/83
1900          0045 ;
1900          0050 ;  INITIALIZATION ROUTINE
1900          0060 ;
1900          0070        ORG   1900H
1900          0080 DINIT  EQU   $
1900 8F       0090        DI                  ; DON'T BOTHER ME DURING SETUP
1901 70 FD    0100        PUSH  RP            ; SAVE OLD REG POINTER
1903 31 30    0110        SRP   #MYREG        ; POINT TO MY WORK REGS
1905 CC 10    0120        LD    R12,#10H      ; POINT TO IRQ 5 VECTOR ADDRESS
1907 DC OF    0130        LD    R13,#OFH      ;
1909 FC 8D    0140        LD    R15,#8DH      ; PICK UP A JUMP COMAND
190B 92 FC    0150        LDE   @RR12,R15     ; WRITE TO VECTOR
190D A0 EC    0160        INCW  R12           ; STEP TO NEXT
190F FC 19    0170        LD    R15,#SCROLL!H ; HIGH BYTE FOR JUMP ADDRESS
1911 92 FC    0180        LDE   @RR12,R15     ; WRITE TO VECTOR +1
1913 A0 EC    0190        INCW  R12           ; STEP TO NEXT
1915 FC C1    0200        LD    R15,#SCROLL!L ; LOW BYTE OF JUMP ADDRESS
1917 92 FC    0210        LDE   @RR12,R15     ; WRITE IT AT VECTOR +2
1919          0220 ;
1919          0230 ;   REGISTER LAYOUT -
1919          0240 ;      RR0 - POINTER TO COLUMN TO OUTPUT
1919          0250 ;      R2  - COUNT OF COLUMNS LEFT TO DISPLAY
1919          0260 ;      R3  - RIPPLE TIMER CONSTANT FOR SCROLLING
1919          0270 ;      R4  - FLAGS BYTE :
1919          0280 ;            BIT 0 - RUN MODE
1919          0290 ;            BIT 1 - UNDEFINED
1919          0300 ;            BIT 2 - BLANK COLUMN SUPPRESS IF SET
1919          0310 ;            BITS 3-7 - UNDEFINED
1919          0320 ;      RR6 - POINTER TO SWITCHES
```

Listing 3 continued on page 42

Listing 3 continued:

```
1919                        ;
1919                        ;
1919 E6 F6 00                       LD      0F6H,#0         ; SET PORT 2 AS ALL OUTPUT
191C E6 02 04                       LD      2,#4            ; DATA=0, CLOCK=0, CLEAR=1
191F E6 02 00                       LD      2,#0            ; DATA,CLOCK,CLEAR=0
1922                        ;   MODE BYTE TO *RUN, BLANKS ENABLED
1922 4C 00                          LD      R4,#0
1924                        ; SET BLANK FLAG FROM SWITCH
1924 82 F6                          LDE     R15,@RR6        ; PICK UP SWITCHES
1926 76 EF 40                       TM      R15,#40H        ; IS BLANK SUPPRESS DESIRED ?
1929 6B 03                          JR      Z,TIMER         ; NO,PROCEED
192B 46 E4 04                       OR      R4,#4H          ; YES, SET BLANK SUPRESS FLAG
192E                        ;   SET UP TIMER, BUT CLEAR INTERRUPT MASK FOR IT
192E                        TIMER   EQU     $
192E 6C FF                          LD      R6,#SWITCH!H    ; HIGH ORDER BYTE OF SWITCHES
1930 7C FD                          LD      R7,#SWITCH!L    ; LOW ORDER BYTE OF SWITCHES
1932 82 36                          LDE     R3,@RR6         ; GET THE BYTE
1934 56 E3 30                       AND     R3,#30H         ; ISOLATE RIPPLE RATE BITS
1937 06 E3 10                       ADD     R3,#10H         ; ADD 16 TO BYTE
193A CC 08                          LD      R12,#TIME!H     ; GET ADDRESS OF
193C DC 00                          LD      R13,#TIME!L     ;  TIMER DATA AREA
193E 92 3C                          LDE     @RR12,R3        ; STORE RATE THERE
1940 E6 F3 03                       LD      PRE1,#03H       ; SET PRESCALE1 TO 64
1943 E6 F2 20                       LD      T1,#20H         ; SET TIMER1 COUNT TO 32
1946 46 F1 0C                       OR      TMR,#0CH        ; START T1 A'COUNTIN'
1949 E6 FB 00                       LD      IMR,#0          ; RESET ALL INTERRUPTS.
194C                        ; RESET BUFFER BEGIN DATA AREA TO 0
194C CC 08                          LD      R12,#BGNBUF!H
194E DC 01                          LD      R13,#BGNBUF!L
1950 FC 00                          LD      R15,#0
1952 92 FC                          LDE     @RR12,R15
1954 A0 EC                          INCW    R12
1956 92 FC                          LDE     @RR12,R15
1958                        ;
1958                        ; TEST FOR INTERNAL/EXTERNAL MODE
1958                        ;
1958 82 F6                          LDE     R15,@RR6        ; GET SWITCHES
195A 76 EF 01                       TM      R15,#1          ; TEST INT/EXT SWITCH
195D 6B 04                          JR      Z,INTERNAL      ; IF 0 THEN INTERNAL MODE
195F                        ;
195F                        ; EXTERNAL MODE MEANS JUST RETURN TO BASIC ?
195F                        ;
195F 50 FD                          POP     RP              ; RESTORE REG POINTER
1961 9F                             EI                      ; ENABLE INTERRUPTS BEFORE EXIT
1962 AF                             RET                     ; RETURN TO CALLER
1963                        ;
1963                        ;
1963                        INTER   EQU     $
1963 D6 19 66                       CALL    INTMSG
1966                        ;
1966                        ;
1966                        ; END OF INIT ROUTINE
1966                        ;
1966                        ;
1966                        ;
1966                        ; INTMSG - SET UP AND SCROLL ONE OF
1966                        ;  THE INTERNALLY STORED MESSAGES
1966                        ;
1966                        ; ASSUMES :
1966                        ;
1966                        ;    INIT HAS BEEN EXECUTED, OR REGS SET
1966                        ;    BY SOME OTHER PROGRAM
1966                        ;
1966                        ;
1966                        INTMS   EQU     $
1966 82 F6                          LDE     R15,@RR6        ; PICK UP SWITCHES
1966 56 EF 0C                       AND     R15,#0CH        ; ISOLATE THE MESSAGE SELECT BITS
196B CC 1A                          LD      R12,#INTTBL!H   ; GET MESSAGE TABLE
196D DC 85                          LD      R13,#INTTBL!L   ;  BASE ADDRESS
196F 02 DF                          ADD     R13,R15         ; ADD IN MESSAGE # OFFSET
1971                        ;
1971                        ; NOTE: THE ABOVE CODE WILL ONLY WORK IF THE
1971                        ; LOW ORDER BYTE DOES NOT OVERFLOW WHEN
1971                        ; 0FH IS ADDED TO IT.
1971                        ;
1971 82 8C                          LDE     R8,@RR12        ; GET MESSAGE BEGIN AND
1973 A0 EC                          INCW    RR12
1975 82 9C                          LDE     R9,@RR12        ;  END POINTERS
1977 A0 EC                          INCW    RR12
1979 82 AC                          LDE     R10,@RR12       ; INTO THEIR
197B A0 EC                          INCW    RR12
197D 82 BC                          LDE     R11,@RR12       ; RESPECTIVE REGISTERS
197F CC 08                          LD      R12,#BGNBUF!H   ; GET ADDRESS OF BEGIN
1981 DC 01                          LD      R13,#BGNBUF!L   ;  MESSAGE SAVE AREA
1983 92 8C                          LDE     @RR12,R8        ; AND SAVE THE
1985 A0 EC                          INCW    RR12
1987 92 9C                          LDE     @RR12,R9        ;  POINTER THERE
1989 D6 19 8E                       CALL    SCRST           ; START THE SCROLL PROCESS
198C                        LOOP    EQU     $
198C 8B FE                          JR      LOOP            ; DO AN INFINITE LOOP
198E                        ;
198E                        ;
198E                        ;
198E                        ;
198E                        ; SCRST - SCROLL START ROUTINE
198E                        ;
198E                        ; ASSUMES :
198E                        ;
198E                        ;     ALL REGS SET EXCEPT COLUMN POINTER
198E                        ;      AND COLUMN COUNTER
198E                        ;
198E                        ;
198E                        SCRST   EQU     $
198E 70 FD                          PUSH    RP              ; SAVE OLD REG POINTER
1990 31 30                          SRP     #MYREG          ; POINT TO MY WORK REGS
1992 82 F8                          LDE     R15,@RR8        ; GET 1ST DATA BYTE FROM BUFFER
1994                        COLSE   EQU     $
1994 56 EF 7F                       AND     R15,#07FH       ; STRIP OFF H.O. BIT
1997 0C 1A                          LD      R0,#CHRTAB!H    ; PICK UP CHRTAB
1999 1C 95                          LD      R1,#CHRTAB!L    ;  BASE ADDRESS
199B A6 EF 00                       CP      R15,#0          ; IS DATA BYTE = 0 ?
199E 6B 0E                          JR      EQ,COLCNT       ; YES, CHRTAB ADDRESS OK
19A0                        SKIP1   EQU     $
19A0 A0 E0                          INCW    RR0             ; STEP OUT
19A2 A0 E0                          INCW    RR0             ;  TO THIS BYTE'S
19A4 A0 E0                          INCW    RR0             ;   TRANSLATE
19A6 A0 E0                          INCW    RR0             ;    AREA
19A8 A0 E0                          INCW    RR0             ;    IN THE
19AA A0 E0                          INCW    RR0             ;     CHRTAB TABLE.
19AC FA F2                          DJNZ    R15,SKIP1       ; DO UNTIL 0
19AE                        COLCN   EQU     $
19AE 2C 06                          LD      R2,#6           ; ASSUME 6 COLUMNS FOR NOW
19B0 76 E4 04                       TM      R4,#4H          ; ARE WE BLANK SUPPRESSING ?
19B3 6B 04                          JR      Z,START         ; NO,ALL IS WELL. CRANK IT UP
19B5 00 E2                          DEC     R2              ; ONLY 5 COLS PER CELL PLEASE
19B7 A0 E0                          INCW    RR0             ; SKIP BLANK COLUMN IN TABLE
19B9                        ;
19B9                        ; START THE INTERRUPTS FOR SCROLLING
19B9                        ;
19B9                        START   EQU     $
19B9 8F                             DI                      ; SHUT DOWN INTERRUPTS (SHOULD BE OFF ANYWAY)
19BA 46 FB 20                       OR      IMR,#20H        ; ALLOW INTERRUPT IRQ5 (T1)
19BD 50 FD                          POP     RP              ;RESTORE REG POINTER
19BF 9F                             EI                      ; TURN ON INTERRUPTS
19C0 AF                             RET                     ; RETURN TO CALLER
19C1                        ;
19C1                        ;
19C1                        ;
```

Listing 3 continued on page 44

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Listing 3 continued:

```
19C1                 ; SCROLL - INTERRUPT DRIVEN SCROLL ROUTINE
19C1                 ;
19C1                 ; ASSUMES :
19C1                 ;
19C1                 ;      ALL POINTER REGS CORRECTLY INITIALIZED
19C1                 ;      REG 3 HAS TIME INCREMENTS REMAINING TO NEXT OUTPUT
19C1                 ;      TIME CONSTANT IS STORED AT "TIME" DATA AREA
19C1                 ;
19C1                 ;
19C1                 SCROL  EQU   $
19C1 70 FD                  PUSH  RP               ; SAVE OLD REG POINTER
19C3 31 30                  SRP   #MYREG           ; POINT TO MY REGS
19C5 3A 48                  DJNZ  R3,RETRN         ; IF INTERVAL HAS NOT EXPIRED, GO AWAY
19C7 CC 06                  LD    R12,#TIME!H      ; POINT TO TIMER
19C9 DC 00                  LD    R13,#TIME!L      ;   CONSTANT DATA AREA
19CB 82 3C                  LDE   R3,@RR12         ; RESTORE FULL COUNT
19CD D6 1A 41               CALL  COLWRT           ; WRITE A COLUMN OF DATA
19D0 A0 E0                  INCW  RR0              ; STEP TO NEXT COLUMN
19D2 2A 3B                  DJNZ  R2,RETRN         ; IF NOT LAST COLUMN, GO AWAY
19D4                 ;
19D4                 ; STEP TO NEXT CHARACTOR IN BUFFER
19D4                 ;
19D4 A0 E8                  INCW  R8               ; ADVANCE CURBUF BY 1
19D6 A2 8A                  CP    R8,R10           ; COMPARE CURBUF AND ENDBUF HIGH BYTE
19D8 7B 0E                  JR    ULT,SETCH        ; IF NOT GE THEN NO WRAP
19DA A2 9B                  CP    R9,R11           ; COMPARE LOW BYTES
19DC 3B 0A                  JR    ULE,SETCH        ; IF NOT GT THEN NO WRAP
19DE                 ;
19DE                 ; WRAP TO BEGINNING OF MESSAGE
19DE                 ;
19DE CC 08                  LD    R12,#BGNBUF!H    ; PICK UP POINTER TO
19E0 DC 01                  LD    R13,#BGNBUF!L    ;   BEGIN BUFFER REMEMBERANCE
19E2 82 8C                  LDE   R8,@RR12         ; GET HIGH BYTE
19E4 A0 EC                  INCW  RR12
19E6 82 9C                  LDE   R9,@RR12         ; AND LOW BYTE
19E8                 ;
19E8                 ; PICK UP CHARACTOR AND PROCESS -
19E8                 ; SET UP POINTER TO TRANSLATE
19E8                 ; TABLE ADDRESS AS WELL AS # OF COLUMNS TO PROCESS
19E8                 ;
19E8                 ;
19E8                 SETCH  EQU   $
19E8 82 F8                  LDE   R15,@RR8         ; GET DATA BYTE FROM BUFFER
19EA 0C 1A                  LD    R0,#CHRTAB!H     ; SET UP POINTER TO
19EC 1C 95                  LD    R1,#CHRTAB!L     ;  DATA TABLE BASE
19EE 56 EF 7F               AND   R15,#7FH         ; MASK OFF H.O. BIT
19F1 A6 EF 00               CP    R15,#0           ; IS DATA BYTE 0?
19F4 6B 0E                  JR    EQ,SETCOL        ; YES, POINTER IN TABLE IS OK.
19F6                 ;
19F6                 ; ADJUST CHRTAB POINTER
19F6                 ;
19F6                 SKIP2  EQU   $
19F6 A0 E0                  INCW  RR0
19F8 A0 E0                  INCW  RR0
19FA A0 E0                  INCW  RR0
19FC A0 E0                  INCW  RR0
19FE A0 E0                  INCW  RR0
1A00 A0 E0                  INCW  RR0
1A02 FA F2                  DJNZ  R15,SKIP2
1A04                 ;
1A04                 ; DETERMINE # OF COLUMNS TO WRITE
1A04                 ; ADJUST CHRTAB POINTER IF NECESSARY
1A04                 ;
1A04                 SETCO  EQU   $
1A04 2C 06                  LD    R2,#6            ; ASSUME 6 COLS TO START
1A06 76 E4 04               TM    R4,#04H          ; TEST COLUMN BLANK FLAG
1A09 6B 04                  JR    Z.RETRN          ; IF 0. THEN BLANK. NO ADJUST
1A0B 00 E2                  DEC   R2               ; IF 1, NO BLANK. ADJUST COL. COUNT
1A0D A0 E0                  INCW  RR0              ;  AND CHRTAB POINTER
1A0F                 RETRN  EQU   $
1A0F 50 FD                  POP   RP               ; RESTORE REG POINTER
1A11 BF                     IRET                   ; RETURN FROM INTERRUPT
1A12                 ;
1A12                 ;
1A12                 ; CHARACTOR OUTPUT ROUTINE - NON-INTERRUPT DRIVEN
1A12                 ;
1A12                 ; ASSUMES :
1A12                 ;
1A12                 ;     BUFFER POINTER IS ON XTER TO BE OUTPUT.
1A12                 ;     CHARACTOR IS INDEX TO LED TABLE
1A12                 ;     SWITCH POINTER REGS ARE INITIALIZED
1A12                 ;
1A12                 ;
1A12                 CHOUT  EQU   $
1A12 70 FD                  PUSH  RP               ; SAVE OLD REG POINTER
1A14 31 30                  SRP   #MYREG           ; POINT TO MY WORK REGS
1A16 82 F8                  LDE   R15,@RR8         ; GET CHARACTOR TO BE DISPLAYED
1A18                 CHFIX  EQU   $
1A18 56 EF 7F               AND   R15,#07FH        ; STRIP OFF H.O. BIT
1A1B                 ;
1A1B                 ; BUILD INDEX INTO TABLE FOR COLUMNS OF DATA
1A1B                 ;
1A1B 0C 1A                  LD    R0,#CHRTAB!H     ; PICK UP TABLE
1A1D 1C 95                  LD    R1,#CHRTAB!L     ;  BASE ADDRESS
1A1F A6 EF 00               CP    R15,#0           ; IS THIS CELL 0 ?
1A22 6B 08                  JR    EQ,SUPRS         ; YES, GO TO BLANK SUPPRESS
1A24                 INDEX  EQU   $
1A24 EC 06                  LD    R14,#6           ; SET UP 6 COLUMNS PER CELL
1A26                 IDXLP  EQU   $
1A26 A0 E0                  INCW  RR0              ; ADD 1 TO COLUMN POINTER
1A28 EA FC                  DJNZ  R14,IDXLP        ; DO FOR 6 COLUMNS
1A2A FA F8                  DJNZ  R15,INDEX        ; DO FOR R15 TIMES
1A2C                 ;
1A2C                 ; NOW CHECK TO SEE IF FIRST COLUMN BLANK IS WANTED
1A2C                 ;
1A2C                 SUPRS  EQU   $
1A2C 2C 06                  LD    R2,#6            ; ASSUME 6 COLUMNS PER CELL NOW
1A2E 76 E4 04               TM    R4,#04H          ; TEST BLANK BIT
1A31 6B 04                  JR    Z,BLANK
1A33 00 E2                  DEC   R2               ; DROP 1 COLUMN COUNT
1A35 A0 E0                  INCW  RR0              ; SKIP BLANK COLUMN
1A37                 BLANK  EQU   $
1A37                 ;
1A37                 ; THIS IS THE OUTPUT ROUTINE FOR THE CELL
1A37                 ;
1A37 D6 1A 41               CALL  COLWRT           ; WRITE THIS COLUMN
1A3A A0 E0                  INCW  RR0              ; STEP TO NEXT ONE
1A3C 2A F9                  DJNZ  R2,BLANK         ; IF NOT DONE, DO IT AGAIN
1A3E 50 FD                  POP   RP               ; RESTORE OLD REG POINTER
1A40 AF                     RET                    ; RETURN TO CALLER
1A41                 ;
1A41                 ; ROUTINE TO WRITE A COLUMN OF LED INFORMATION
1A41                 ;
1A41                 ; ASSUMES :
1A41                 ;     REGS R0+R1 POINT TO THE BYTE TO OUTPUT
1A41                 ;     REG4 BIT 2 INDICATES INVERSE VIDEO IF SET
1A41                 ;     THE CLOCK BIT IS 0 ON ENTRY
1A41                 ;     REG 2 IS CORRECTLY SET FOR OUTPUT
1A41                 ;
1A41                 COLWR  EQU   $
1A41 70 FD                  PUSH  RP               ; SAVE OLD REG POINTER
1A43 31 30                  SRP   #MYREG           ; POINT TO MY WORK REGS
1A45 82 F0                  LDE   R15,@RR0         ; PICK UP DATA BYTE
1A47 90 EF                  RL    R15              ; ADJUST COLUMN CORRECTLY
1A49 EC 08                  LD    R14,#8           ; DO THIS 8 TIMES
```

Listing 3 continued on page 46

Now there's a real-time video image acquisition and display module that plugs directly into the IBM PC and PC-XT.

It's called the PCVISION™ Frame Grabber. From Imaging Technology —the leading OEM supplier of low cost, board level image processors.

The PCVISION Frame Grabber converts a standard analog video signal (RS-170) from a camera to digital data at 30 frames per second, and stores the resulting 6-bit pixel data in a 512 × 512 frame memory.

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Listing 3 continued:

```
1A4B                BITLO  EQU   $
1A4B D6 EF                 LD    R13,R15
1A4D 56 ED 01              AND   R13,#1       ; SAVE DATA BIT. RESET ALL OTHERS
1A50 D9 02                 LD    2,R13        ; AND PUT DATA BIT ON PORT 2
1A52 46 ED 02              OR    R13,#2       ; TURN ON CLOCK BIT
1A55 FF                    NOP                ; WAIT A LITTLE BIT
1A56 FF                    NOP
1A57 FF                    NOP
1A58 FF                    NOP
1A59 D9 02                 LD    2,R13        ; AND WRITE TO PORT 2
1A5B 56 ED 01              AND   R13,#1       ; TURN OFF CLOCK BIT
1A5E FF                    NOP                ; WAIT A LITTLE BIT
1A5F FF                    NOP
1A60 FF                    NOP
1A61 FF                    NOP
1A62 D9 02                 LD    2,R13        ; AND WRITE TO PORT 2
1A64 E0 EF                 RR    R15          ; SET REG 15 TO NEXT BIT
1A66 FF                    NOP                ; WAIT A LITTLE WHILE
1A67 FF                    NOP                ;
1A68 FF                    NOP                ;
1A69 FF                    NOP                ;
1A6A EA DF                 DJNZ  R14,BITLOOP  ; DO UNTIL ALL BITS FINISHED
1A6C 50 FD                 POP   RP           ; RESTORE OLD REG POINTER
1A6E AF                    RET                ; GO BACK TO CALLER
1A6F                ;
1A6F                ;
1A6F                ;
1A6F                ;
1A6F                ;  CLEAR THE DISPLAY ROUTINE
1A6F                ;
1A6F                ;  ASSUMES :
1A6F                ;
1A6F                ;      PORT 2 IS CORRECTLY CONFIGURED FOR OUTPUT
1A6F                ;
1A6F                CLEAR  EQU   $
1A6F E6 02 04              LD    2,#04H       ; CLEAR ON, CLOCK AND DATA LOW
1A72 E6 02 00              LD    2,#0H        ; TURN OFF CLEAR
1A75 AF                    RET                ; RETURN TO CALLER
1A76                ;
1A76                ;
1A76                ;
1A76                ; RIPPLE - SET RIPPLE CLOCK RATE FOR
1A76                ; SCROLL MODE
1A76                ;
1A76                ; ASSUMES :
1A76                ;
1A76                ;     NEW RIPPLE RATE IN REG 13 (ABSOLUTE)
1A76                ;
1A76                ;
1A76                RIPPL  EQU   $
1A76 70 FD                 PUSH  RP           ; SAVE OLD REG POINTER
1A78 31 30                 SRP   #MYREG       ; SET REG POINTER TO MY REGS
1A7A CC 08                 LD    R12,#TIME!H  ; POINT TO TIMER
1A7C DC 00                 LD    R13,#TIME!L  ;  DATA AREA
1A7E F8 13                 LD    R15,13H      ; GET PASSED PARM. INTO WORG REG
1A80 92 FC                 LDE   @RR12,R15    ; STORE NEW RIPPLE RATE
1A82 50 FD                 POP   RP           ; RESTORE OLD REG POINTER
1A84 AF                    RET                ; RETURN TO CALLER
1A85                ;
1A85                ;
1A85                ;
1A85                ; DATA AREAS AND CONSTANTS
1A85                ;
1A85                MYREG  EQU   30H
1A85                SWITC  EQU   0FFFDH
1A85                TIME   EQU   0800H
1A85                BGNBU  EQU   TIME+1
1A85                INTTB  EQU   $
1A85 1C D5                 DW    #MSG1BGN
1A87 1C E6                 DW    #MSG1END
1A89 1C E7                 DW    #MSG2BGN
1A8B 1D 17                 DW    #MSG2END
1A8D 1D 18                 DW    #MSG3BGN
1A8F 1D 62                 DW    #MSG3END
1A91 1D 63                 DW    #MSG4BGN
1A93 1D A6                 DW    #MSG4END
1A95                CHRTA  EQU   $
1A95                       DS    192          ; (20H * 6)
1B55                SPECI  EQU   $
1B55 00 00 00 00 00        DB    0,0,0,0,0,0
     00
1B5B 00 00 00 7D 00        DB    0,0,0,7DH,0,0
     00
1B61 00 00 70 00 70        DB    0,0,70H,0,70H,0
     00
1B67 00 14 7F 14 7F        DB    0,14H,7FH,14H,7FH,14H
     14
1B6D 00 12 2A 7F 2A        DB    0,12H,2AH,7FH,2AH,24H
     24
1B73 00 62 64 08 13        DB    0,62H,64H,08H,13H,23H
     23
1B79 00 36 49 35 02        DB    0,36H,49H,35H,02H,05H
     05
1B7F 00 00 00 70 00        DB    0,00,00,70H,00,00
     00
1B85 00 1C 22 41 00        DB    0,1CH,22H,41H,0,0
     00
1B8B 00 00 00 41 22        DB    0,0,0,41H,22H,1CH
     1C
1B91 00 22 14 7F 14        DB    0,22H,14H,7FH,14H,22H
     22
1B97 00 08 08 3E 08        DB    0,08H,08H,3EH,08H,08H
     08
1B9D 00 00 01 06 00        DB    0,0,1,6,0,0
     00
1BA3 00 08 08 08 08        DB    0,8,8,8,8,8
     08
1BA9 00 00 00 01 00        DB    0,0,0,1,0,0
     00
1BAF 00 02 04 08 10        DB    0,2,4,8,10H,20H
     20
1BB5                ; NUMBERS
1BB5 00 3E 45 49 51        DB    0,3EH,45H,49H,51H,3EH
     3E
1BBB 00 00 21 7F 01        DB    0,0,21H,7FH,01,0
     00
1BC1 00 23 45 49 49        DB    0,23H,45H,49H,49H,31H
     31
1BC7 00 42 41 49 59        DB    0,42H,41H,49H,59H,66H
     66
1BCD 00 0C 14 24 7F        DB    0,0CH,14H,24H,7FH,04H
     04
1BD3 00 72 51 51 51        DB    0,72H,51H,51H,51H,4EH
     4E
1BD9 00 1E 29 49 49        DB    0,1EH,29H,49H,49H,46H
     46
1BDF 00 40 47 48 50        DB    0,40H,47H,48H,50H,60H
     60
1BE5 00 36 49 49 49        DB    0,36H,49H,49H,49H,36H
     36
1BEB 00 31 49 49 4A        DB    0,31H,49H,49H,4AH,3CH
     3C
1BF1                ; MORE SPECIAL CHARACTORS
1BF1 00 00 00 14 00        DB    0,0,0,14H,0,0
     00
1BF7 00 00 01 16 00        DB    0,0,1,16H,0,0
     00
1BFD 00 08 14 22 41        DB    0,8,14H,22H,41H,0
```

Listing 3 continued on page 48

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Listing 3 continued:

```
     00
1C03 00 14 14 14 14      DB   0,14H,14H,14H,14H,14H
     14
1C09 00 00 41 22 14      DB   0,0,41H,22H,14H,08H
     08
1C0F 00 20 40 4D 50      DB   0,20H,40H,4DH,50H,20H
     20
1C15                     ; AT SIGN AND LETTERS (UPPER CASE)
1C15 00 3E 41 5D 4D      DB   0,3EH,41H,5DH,4DH,39H
     39
1C1B 00 1F 24 44 24      DB   0,1FH,24H,44H,24H,1FH
     1F
1C21 00 7F 49 49 49      DB   0,7FH,49H,49H,49H,36H
     36
1C27 00 3E 41 41 41      DB   0,3EH,41H,41H,41H,22H
     22
1C2D 00 7F 41 41 41      DB   0,7FH,41H,41H,41H,3EH
     3E
1C33 00 7F 49 49 49      DB   0,7FH,49H,49H,49H,41H
     41
1C39 00 7F 48 48 48      DB   0,7FH,48H,48H,48H,40H
     40
1C3F 00 3E 41 41 45      DB   0,3EH,41H,41H,45H,47H
     47
1C45 00 7F 08 08 08      DB   0,7FH,08H,08H,08H,7FH
     7F
1C4B 00 00 41 7F 41      DB   0,00H,41H,7FH,41H,00H
     00
1C51 00 02 01 01 01      DB   0,02H,01H,01H,01H,7EH
     7E
1C57 00 7F 08 14 22      DB   0,7FH,08H,14H,22H,41H
     41
1C5D 00 7F 01 01 01      DB   0,7FH,01H,01H,01H,01H
     01
1C63 00 7F 20 18 20      DB   0,7FH,20H,18H,20H,7FH
     7F
1C69 00 7F 10 08 04      DB   0,7FH,10H,08H,04H,7FH
     7F
1C6F 00 3E 41 41 41      DB   0,3EH,41H,41H,41H,3EH
     3E
1C75 00 7F 48 48 48      DB   0,7FH,48H,48H,48H,30H
     30
1C7B 00 3E 41 45 42      DB   0,3EH,41H,45H,42H,3DH
     3D
1C81 00 7F 48 4C 4A      DB   0,7FH,48H,4CH,4AH,31H
     31
1C87 00 32 49 49 49      DB   0,32H,49H,49H,49H,26H
     26
1C8D 00 40 40 7F 40      DB   0,40H,40H,7FH,40H,40H
     40
1C93 00 7E 01 01 01      DB   0,7EH,01H,01H,01H,7EH
     7E
1C99 00 7C 02 01 02      DB   0,7CH,02H,01H,02H,7CH
     7C
1C9F 00 7F 02 0C 02      DB   0,7FH,02H,0CH,02H,7FH
     7F
1CA5 00 63 14 08 14      DB   0,63H,14H,08H,14H,63H
     63
1CAB 00 60 10 0F 10      DB   0,60H,10H,0FH,10H,60H
     60
1CB1 00 43 45 49 51      DB   0,43H,45H,49H,51H,61H
     61
1CB7 00 7F 7F 41 41      DB   0,7FH,7FH,41H,41H,41H
     41
1CBD 00 20 10 08 04      DB   0,20H,10H,08H,04H,02H
     02
1CC3 00 41 41 41 7F      DB   0,41H,41H,41H,7FH,7FH
     7F
1CC9 00 04 08 10 08      DB   0,04H,08H,10H,08H,04H
     04
1CCF 00 01 01 01 01      DB   0,01H,01H,01H,01H,01H
     01
1CD5                     ;
1CD5                     ;
1CD5                     ; END OF CHRTAB
1CD5                     ;
1CD5                     ;
1CD5                     ;
1CD5                     ; TEST MESSAGES FOR INTERNAL USE
1CD5                     ;
1CD5                     MSG1B   EQU  $
1CD5 54 45 53 54 20              DB   'TEST MESSAGE 1'
     4D 45 53 53 41
     47 45 20 31
1CE3 2E 2E 2E 2E                 DB   '....'
1CE7                     MSG1E   EQU  $-1
1CE7                     MSG2B   EQU  $
1CE7 54 48 45 20 51              DB   'THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG '
     55 49 43 4B 20
     42 52 4F 57 4E
     20 46 4F 58 20
     4A 55 4D 50 45
     44 20 4F 56 45
     52 20 54 48 45
     20 4C 41 5A 59
     20 44 4F 47 20
1D14 2E 2E 2E 2E                 DB   '....'
1D18                     MSG2E   EQU  $-1
1D18                     MSG3B   EQU  $
1D18 30 20 31 20 32              DB   '0 1 2 3 4 5 6 7 8 9 '
     20 33 20 34 20
     35 20 36 20 37
     20 38 20 39 20
1D2C 21 20 22 20 23              DB   '! " # $ % & ( ) * : = - @ + ; , . / ? '
     20 24 20 25 20
     26 20 28 20 29
     20 2A 20 3A 20
     3D 20 2D 20 40
     20 2B 20 3B 20
     2C 20 2E 20 2F
     20 3F 20
1D52 27 20 5B 20 5D              DB   027H,020H,05BH,020H,05DH,020H
     20
1D58 3C 20 3D 20 2E              DB   03CH,020H,03DH,020H,'. . . .'
     20 2E 20 2E 20
     2E
1D63                     MSG3E   EQU  $-1
1D63                     MSG4B   EQU  $
1D63 20 43 49 41 52              DB   ' CIARCIA',027H,'S CIRCUIT CELLAR IS '
     43 49 41 27 53
     20 43 49 52 43
     55 49 54 20 43
     45 4C 4C 41 52
     20 49 53 20
1D80 53 55 50 50 4F              DB   'SUPPORTED BY CURLEW',027H,'S SOFTWARE CELLAR ...'
     52 54 45 44 20
     42 59 20 43 55
     52 4C 45 57 27
     53 20 53 4F 46
     54 57 41 52 45
     20 43 45 4C 4C
     41 52 20 2E 2E
     2E
1DA9                     MSG4E   EQU  $-1
1DA9                     ;
1DA9                     ; END OF TEST MESSAGES
1DA9                     ;
```

SYMBOL TABLE

Listing 3 continued on page 50

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Listing 3 continued:

```
BGNBU 0001   BITLO 1A4B   BLANK 1A37   CHFIX 1A18   CHOUT 1A12
CHRTA 1A95   CLEAR 1A6F   COLCN 19AE   COLSE 1994   COLWR 1A41
DINIT 1900   IDXLP 1A26   INDEX 1A24   INTER 1963   INTMS 1966
INTTB 1A85   LOOP  198C   MSG1B 1CD5   MSG1E 1CE6   MSG2B 1CE7
MSG2E 1D17   MSG3B 1D16   MSG3E 1D62   MSG4B 1D63   MSG4E 1DA6
MYREG 0030   RETRN 1A0F   RIPPL 1A76   SCROL 19C1   SCRST 198E
SETCH 19E8   SETCO 1A04   SKIP1 19A0   SKIP2 19F6   SPECI 1B55
START 19B9   SUPRS 1A2C   SWITC FFFD   TIME  0800   TIMER 192E
```

Listing 4: *The display-control program operating in the echo mode produces output on the video-display terminal like that shown here.*

```
CREATE A DISPLAY MENU

1 - BUILD A NEW MESSAGE
2 - START MESSAGE SCROLLING
3 - CHANGE SCROLL RATE OF DISPLAY
4 - EDIT THE STORED MESSAGE

? 1

ENTER DISPLAY CHARACTERS. END WITH RETURN OR ENTER KEY
TUST

CREATE A DISPLAY MENU

1 - BUILD A NEW MESSAGE
2 - START MESSAGE SCROLLING
3 - CHANGE SCROLL RATE OF DISPLAY
4 - EDIT THE STORED MESSAGE

? 4

LISTING OF CURRENT MESSAGE
TUST

AS EACH CHARACTER IS DISPLAYED, ENTER + TO SKIP,C TO CHANGE
TYPE Q TO QUIT LEAVING REST OF MESSAGE,
TYPE E TO QUIT ENDING MESSAGE AT THIS CHARACTER
T ? +
U ? C
NEW CHARACTER ? E
E ? +
S ? +
T ? +
END OF ORIGINAL MESSAGE
TYPE ADDITIONAL CHARACTERS AND END WITH RETURN OR ENTER
 MESSAGE FOR DISPLAY ....

CREATE A DISPLAY MENU

1 - BUILD A NEW MESSAGE
2 - START MESSAGE SCROLLING
3 - CHANGE SCROLL RATE OF DISPLAY
4 - EDIT THE STORED MESSAGE

? 4

LISTING OF CURRENT MESSAGE
TEST MESSAGE FOR DISPLAY ....

AS EACH CHARACTER IS DISPLAYED, ENTER + TO SKIP,C TO CHANGE
TYPE Q TO QUIT LEAVING REST OF MESSAGE,
TYPE E TO QUIT ENDING MESSAGE AT THIS CHARACTER
T ? Q

CREATE A DISPLAY MENU

1 - BUILD A NEW MESSAGE
2 - START MESSAGE SCROLLING
3 - CHANGE SCROLL RATE OF DISPLAY
4 - EDIT THE STORED MESSAGE

? 2


CREATE A DISPLAY MENU

1 - BUILD A NEW MESSAGE
2 - START MESSAGE SCROLLING
3 - CHANGE SCROLL RATE OF DISPLAY
4 - EDIT THE STORED MESSAGE

? 3

ENTER NEW SCROLL RATE
? 2


CREATE A DISPLAY MENU

1 - BUILD A NEW MESSAGE
2 - START MESSAGE SCROLLING
3 - CHANGE SCROLL RATE OF DISPLAY
4 - EDIT THE STORED MESSAGE

? 3

ENTER NEW SCROLL RATE
? 20


CREATE A DISPLAY MENU

1 - BUILD A NEW MESSAGE
2 - START MESSAGE SCROLLING
```

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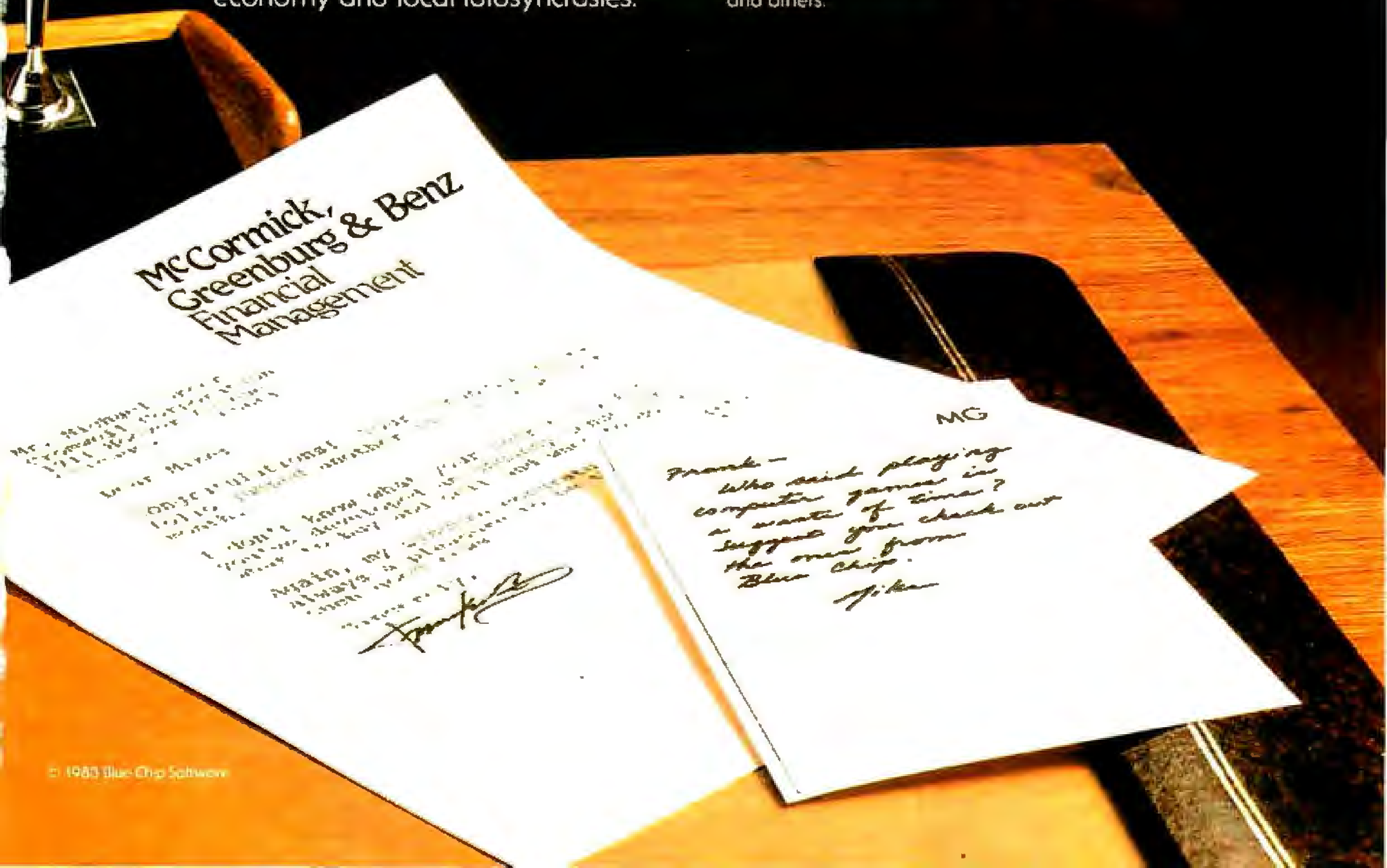

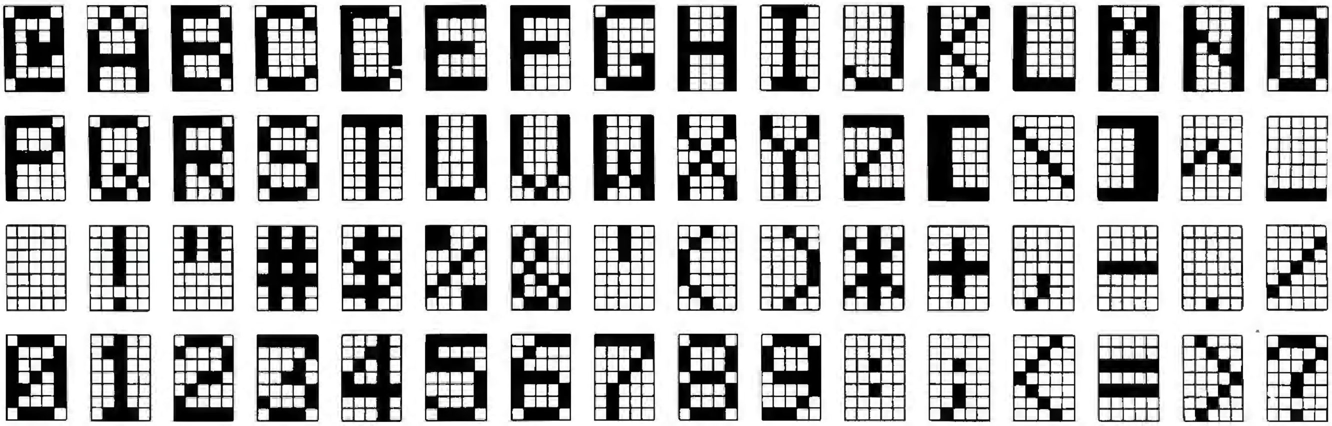

Figure 8: *An entire set of alphanumeric characters can be represented by these bit patterns in a 5- by 7-element matrix, that formed by the LED arrangement in figure 2.*

Photo 6: *In the finished project, multiple character segments are linked and housed together in an attractive wooden enclosure. Either canned or live messages can be written or continuously scrolled across the array under control of the Z8 software.*

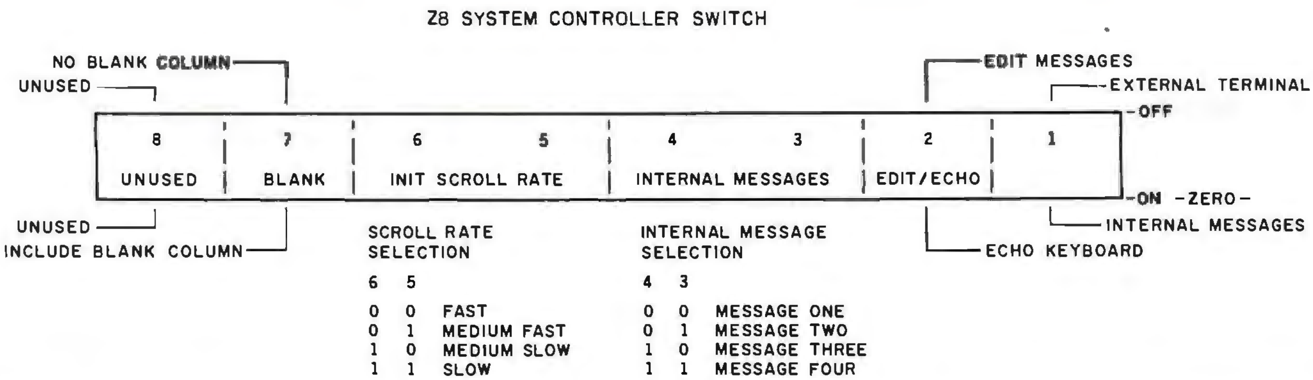

Figure 9: *Options that can be selected by DIP-switch settings on the Z8 board. When used without a terminal, the controller can be thereby set up to start automatically and display one of four prestored messages at one of four scrolling rates.*

Text continued from page 38:

terminal attached to the Z8 board to set up or change the scrolled message, but not for mere continuous operation with a single message. When a terminal is used and the echo mode is selected, input data or other keyboard entries appear in real time on the display. In the nonecho mode, the terminal is used to enter complete messages for subsequent display, to set the scroll rate, or to edit existing messages.

Several options can be selected by DIP (dual-inline pin)-switch settings on the Z8 board, as shown in figure 9. When used without a terminal, the controller can be switch-selected to start automatically and display one of four prestored messages at one of four scrolling rates. Automatic operation would be appropriate if the LED display were used for advertising, housed in an attractive wooden enclosure just like a commercial unit,

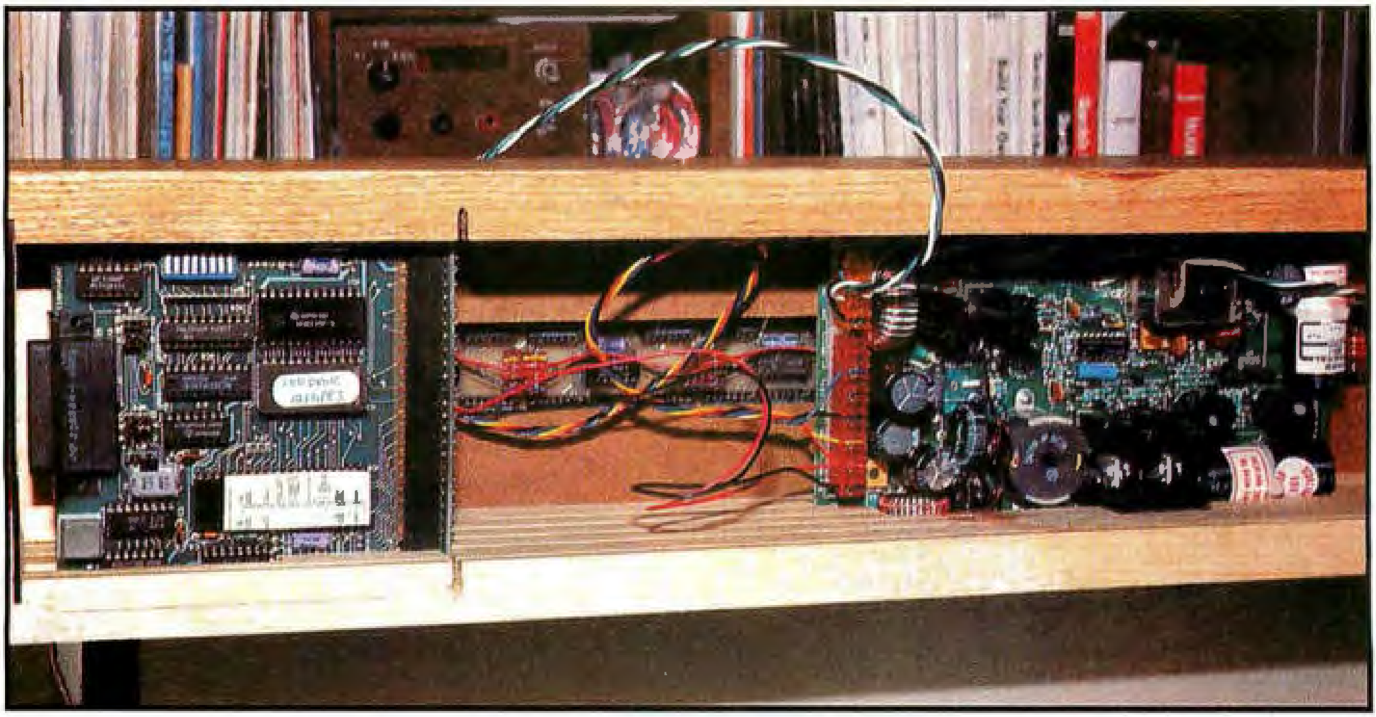

Photo 7: *The Z8-BASIC System Controller and a hefty switching-type power supply reside in the rear of the wooden box.*

as shown in photo 6. (In the rear of the box are the Z8 board and a high-current switching power supply, as photo 7 reveals.)

In Conclusion

The assembly-language routines written for the Z8 could be converted to other processors without too much trouble. If you get ambitious and perform this conversion or devise some clever ways to use the LED display, let me know. I'd like to see your ideas and make them available to others.

I've only begun to find uses for my scrolling LED display. In another month or so, I should be able to add 20 or 30 more character segments. I wonder if I'll ever get to build a 24-line by 80-character display screen?

Next Month:

If you'd like to speed up execution of high-level-language programs on your IBM PC, you'll be interested in a 16-bit coprocessor card you can build.

Steve Ciarcia (pronounced "see-ARE-see-ah") is an electronics engineer and computer consultant with experience in process control, digital design, nuclear instrumentation, product development, and marketing. In addition to writing for BYTE, he has published several books. He can be contacted at POB 582, Glastonbury, CT 06033.

Oops!

In last month's article, we said that this month's project would be the IBM PC coprocessor board. Steve had to delay that project, but your disappointment will be only temporary—you'll see it in May. . . . **R.S.S.**

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

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

References

1. Ciarcia, Steve. "Build a Z8-Based Control Computer with BASIC." Part 1, BYTE, July 1981, page 38. Part 2, BYTE, August 1981, page 50.
2. Ciarcia, Steve. "Self-Refreshing LED Graphics Display." BYTE, October 1979, page 58.

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

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Special thanks to Bill Curlew and Ray Long for their contributions to this project.

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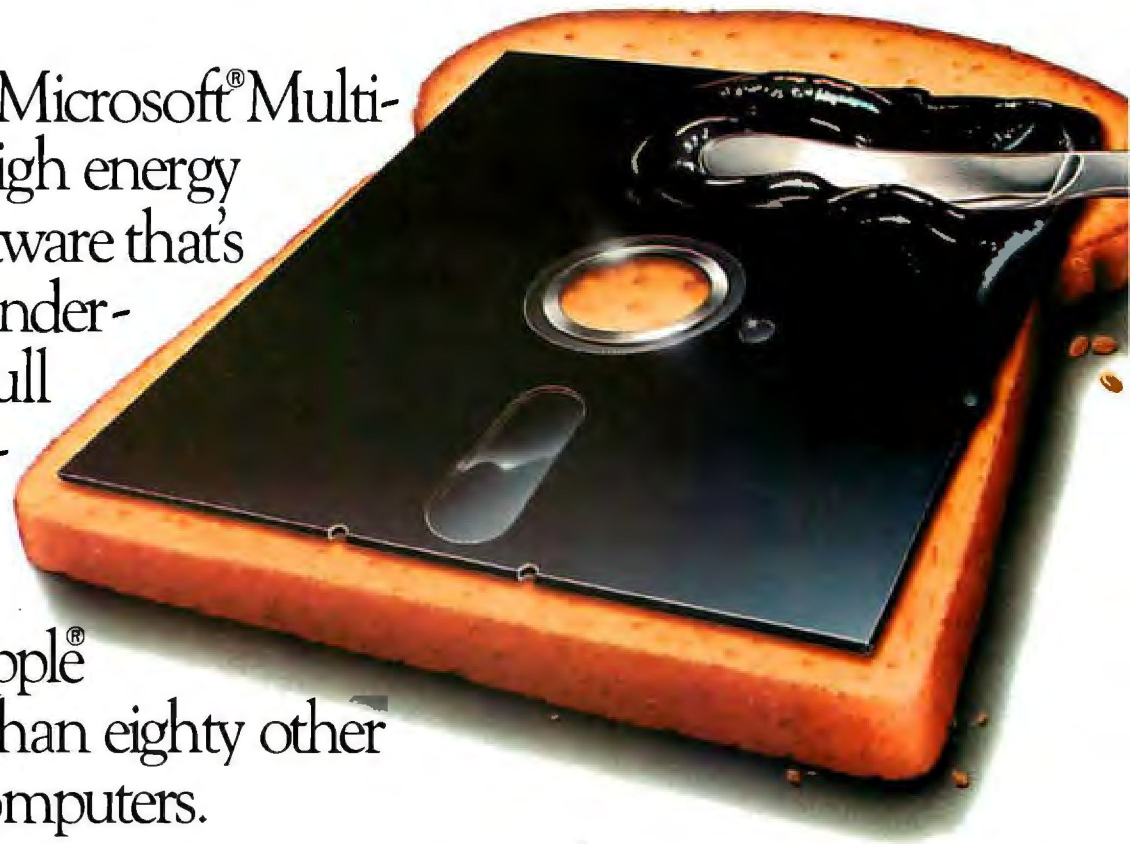

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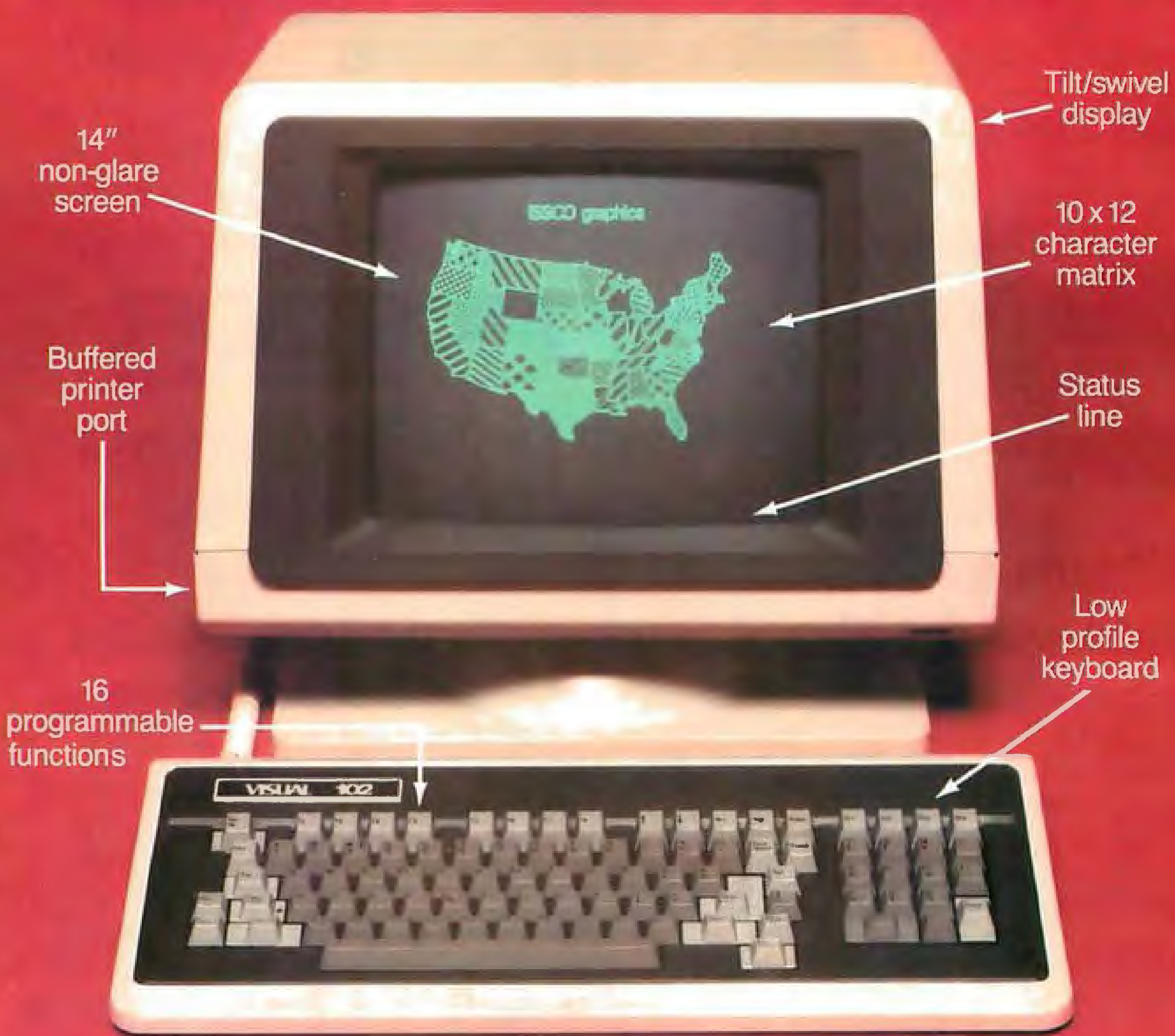

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The Most Fabulous Object in the Entire World

Ain't love grand, Diser, and lots more from Chaos Manor

Jerry Pournelle
Consulting Editor

We've just finished December.

It's axiomatic among writers that nothing happens during December. All the New York publishers vanish from about the first of December until the second week in January. No manuscripts are accepted, no contracts are issued, and no checks are mailed.

Computer companies seem to follow the same practice. Although people at COMDEX promised us a bundle of software and a whole slew of upgrade boards for the IBM PC, very little came in to Chaos Manor during December. I suppose that's just as well since I need to catch up with the backlog. But first—

The Most Fabulous Object in the Entire World

I fell in love at COMDEX.

One booth was occupied by the B. A. Pargh Company, which sells from an enormous catalog full of items ranging from calculating machines to cigars; apparently it carries whatever the company's president wants to carry. Pargh will sell you (if you're a dealer) a Darth Vader Speakerphone, or even a Kermit the Frog phone if you're mad enough to want one.

This interesting outfit shared its booth with a real showstopper. Imagine a clear glass globe about 18 inches in diameter. Fill it with blue-green lightning bolts springing from a sun-red orb in the center. Touch the outside of the globe and the lightning comes to your hands and plays about on the inner surface.

I'm watching mine as I write this. Fingers of lightning leap and play—no. There's no real way to describe this in words. You'd have to see it. It's magnificent.

The Orb Corporation has created a new kind of art object, one that allows you to make ephemeral light sculptures by running your hands over the globe to control the lightning. It's called an Omnisphere. As I said, it's a clear, hollow glass globe on a black pedestal. Inside the globe is a carefully prepared mixture of 15 rare gases in a near vacuum. Three microprocessors (see, there *is* a connection!) control the generation of a high-voltage ultrahigh-frequency current that leaps to form a plasma. Controls on the front allow you to change the intensity, frequency, and other characteristics of the display.

The Omnisphere comes with a 20-year guarantee. It's like nothing you've ever seen. Not cheap, and certainly not for everyone; but you can't buy mine for any price.

Diser

Last year at the West Coast Computer Faire I was much impressed by Lilith, the machine developed in Europe and used by Niklaus Wirth to design Modula-2. Modula-2, for those few who tuned in late, is a structured language best described as "Pascal with the bugs out."

Like most machines for graphics, Lilith is built around the AMD 2901 bit-slicer central processing unit. Alex says bit-slicer means the designers took a bunch of little chips and made them into one big one. The advantage is in the graphics capability: the machine can control a bit-mapped screen dot by dot and do it *fast*.

It turns out that the Diser Company is building a U.S. version of Lilith, which it introduced at COMDEX East last spring. Like Lilith's operating system, the one in the Diser is written in Modula-2, so that it's easy to tinker with and improve, and the machine is a nearly ideal development system for working with Modula-2. It's somewhat more expensive than the microcomputers I write about, so I paid it little attention.

Then I got more involved with Modula-2 and decided to write a book on the language. One thing led to another, and I found myself talking to Heinz Waldberger, president of Diser, and this afternoon one of the machines arrived.

The Diser is *big*; the main unit sits on casters on the floor and measures about 30 inches high by 15 inches wide by 30 inches deep. This contains a card cage, power supply, *four* fans, and a removable-cartridge 10-megabyte hard disk. There aren't any floppies yet, but that's due to change soon; in the meantime, I'll have to use the RS-232C serial port to exchange program source code with the Sage II.

The rest of the machine consists of a big bit-mapped screen similar to the Corvus Concept—like the Corvus, it's taller than it is wide—a Keytronic keyboard, and a Logitech mouse. The keyboard is laid out in the Selectric style. There aren't any arrow keys, but then it doesn't need them since the mouse is intended for cursor control. It's essentially the same keyboard that Keytronic provides as an alternative to the IBM PC keyboard—see my review that follows.

The Diser arrived in three enormous boxes. On one was taped an envelope on how to assemble it. The first thing the instructions did was list the contents of one of the boxes: keyboard, mouse, three cables, two disk cartridges, and the system documents. Alas, there was only *one* disk cartridge, and no documents at all. Given that the machine was rushed out on special order for me, this wasn't all that surprising, and a quick call to Orem, Utah, produced an apology and a promise of documents by Federal Express. The second disk cartridge would have been an exact duplicate of the first, intended for backup; we'll get one of those, too.

Assembly took a bit more than an hour, after which we fired it up. At first we couldn't do anything, but Alex continued to poke at the machine until he found that typing "?" produced some useful Help files. In poking around, we also found machine-readable text files of some of the system documents. I'm writing to catch a deadline; Alex is in the far corner poking the machine. Every now and then he shouts "Wow!" or words to that effect when he finds something new.

Control of the Diser has some similarities to Apple's Lisa but isn't such an insult to the intelligence. Pushing buttons on the mouse produces a miniwindow with a menu of options; moving the mouse within that miniwindow selects among the options. Some of the options have suboptions, also selectable by skillful use of the mouse. I can see how one could become quite adept with a little practice. For example, many editing functions, like insert, delete, and move text, are done with the mouse. Unlike Lisa, the Diser does all this *fast*.

We found illustrations of the machine's graphics capabilities under a file called DEM.COMDEX.DEMO; running that produces a dazzling display of three-dimensional graphics, including bit-map photographs of Swiss castles, as well as a pastoral scene with guernsey cows—I wonder if they've been to Peterborough lately? **[Editor's Note:** *Here at BYTE we are ensconced in the former headquarters of the American Guernsey Cattle Club.*]

Obviously, the Diser can store and display photographs. You can also draw pictures and diagrams with the mouse. Of course, you then need a printer capable of reproducing them on paper.

The Diser is intended for use with a laser printer. Diser has mated Canon's big and fancy laser printer to

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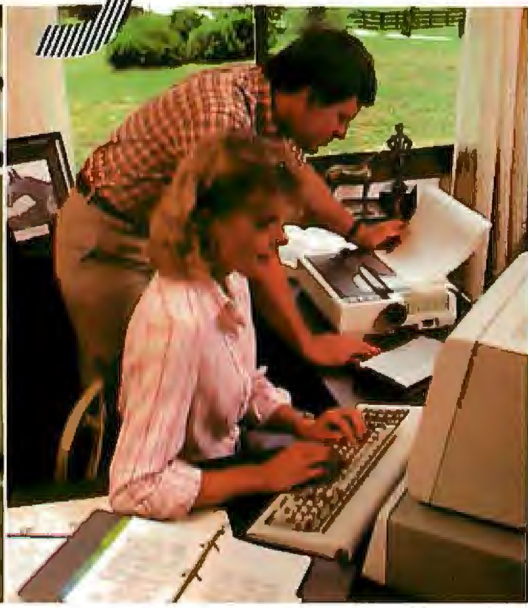
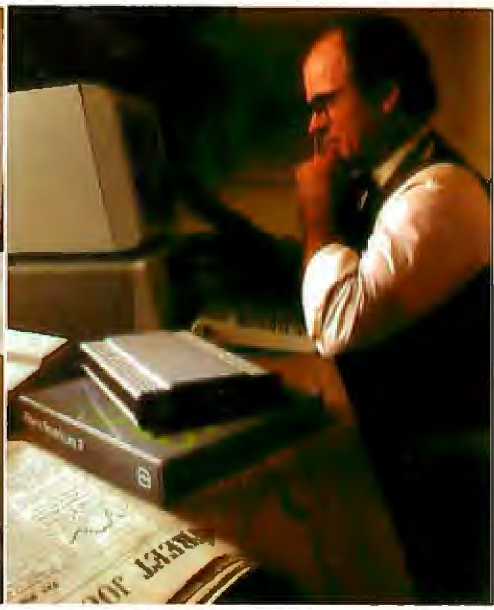


Gary: The pedigrees for next week's auction are as follows...



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

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the machine, but I can't afford one of those. However, the company expects to have it working with Canon's new low-cost cartridge laser printer—see my COMDEX report in the March BYTE (page 352)—Real Soon Now. The delay is not Diser's. Canon hasn't yet delivered the printer. The Canon is only one of a whole bunch of new and comparatively low cost (less than $4000) fast laser printers. Xerox and Fujitsu are also contenders. I certainly intend to get one of them.

You can also interface the Diser to a high-quality dot-matrix printer, such as the Printmate 150, and until we can get a laser printer that will just have to do.

Meanwhile, I'm already impressed with the Diser. I've seen it format text and then present it in fancy type fonts on screen. I've been playing with the text editor; it's certainly usable, although it will take a while to become skillful with the mouse.

I like Diser's character sets; it gives you a choice of about a dozen type fonts, including Helvetica, Gothic, and Times Roman. On the other hand, I'm not as fond of black on white as Diser is, and the letters on the screen are smaller than I'm used to; I find myself getting closer to it, which means I have to tilt my head back and look through the bottoms of my bifocals, which does my posture no good at all. No matter: you can change the default type font in the text editor to be as large as you like, and if I really fall in love with the machine, I'll get one of the *enormous* Dotronix bit-mapped screens we saw at COMDEX.

Meanwhile, this machine, plus a laser printer, can produce camera-ready copy, giving authors total control of their books. That could be important to me, especially if Larry Niven and I do any more novels requiring complex typography, as *Oath of Fealty* did. In *Oath* we used different typefaces to indicate various modes of communication: humans speaking to computers; computers speaking to humans; humans conversing with computers through implanted transceivers; humans conversing with each other by means of the implants; computers writing to screens; and so forth. It got a bit complicated, and the typesetters didn't get it perfect even after a number of telephone calls. With the Diser and a good laser printer, I could send final page copy to my publisher.

Of course, it's no use counting one's chickens before they're hatched; after all, I've had the machine only a few hours, and we won't really know what it can do until we have the documents and get a chance to thrash it about. It will certainly have some pretty severe limits, since there's not much software for it. I suppose there is somewhere a Pascal compiler for the Diser, so I could recompile any Pascal programs I have source code for; but most of the programs I use every day would have to be rewritten in Modula-2.

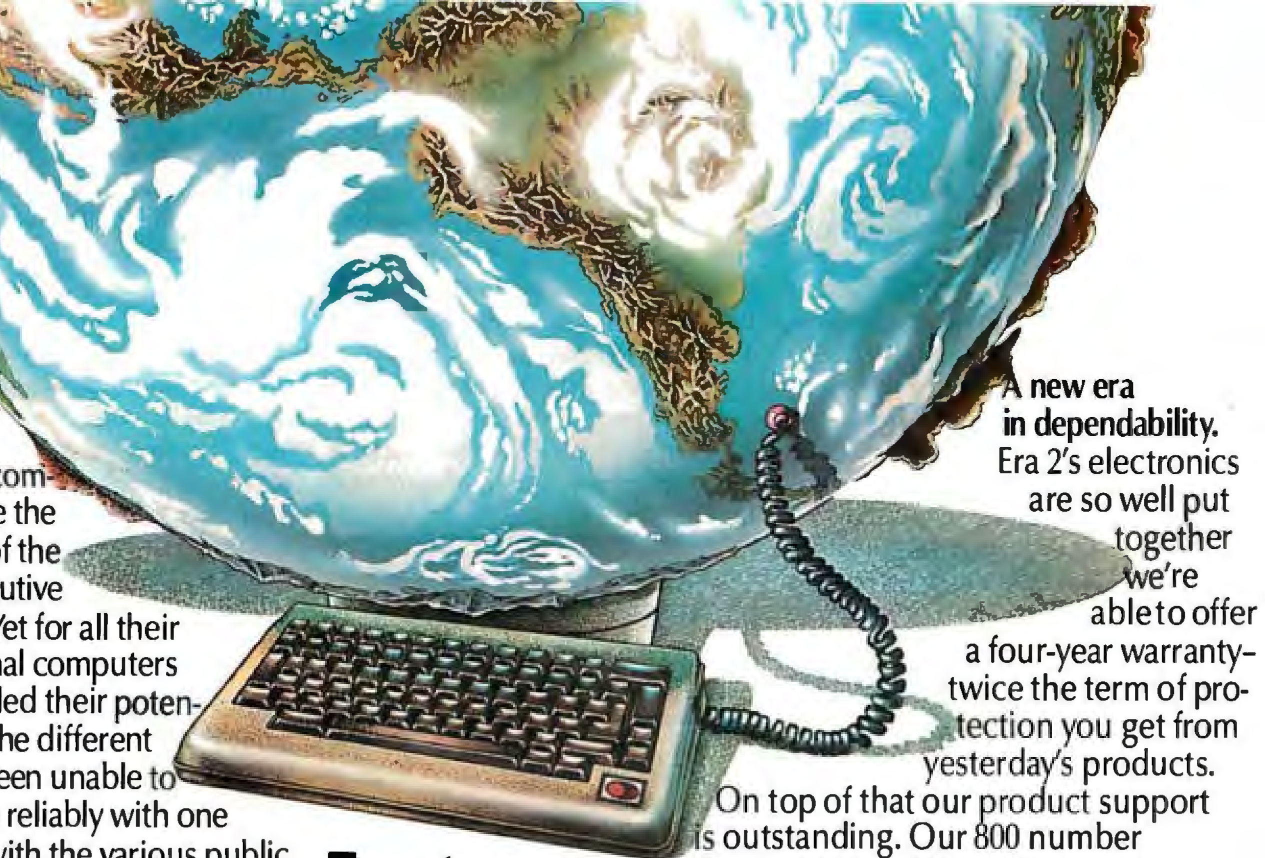
On the other hand, Modula-2 is, in my judgment, the real language of the future, and it won't be long before there's a lot of software written in Modula-2, including accounting packages and the like; for that matter, it wouldn't be all that difficult to translate my own accounting programs from structured Compiling CBASIC to Modula-2, and the programs would be the better for the change.

What all this means, really, is that I'll certainly have a lot more to say about the Diser in months to come.

Desk Organizer

One reason I anxiously awaited our IBM PC was a program whose description made it appear to be precisely what I wanted: a combination telephone directory, notepad, desk calculator, and clock/calendar with scheduler and alarm. It's called Desk Organizer, from an outfit called Conceptual Instruments Company, and from the description I was sure it would be great. Moreover, it works under a sort of concurrent operating system: you boot up with the Desk Organizer disk, and once it's running you can bring up the regular IBM PC operating system and run other programs, such as a text editor. The Desk Organizer is said to be still in the system, ready to be called up—something like Concurrent CP/M-86. If you have lots of memory, you can freely

Era one.



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A closer look at Era 2.

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switch back and forth between Desk Organizer and another program.

This sounded ideal. One of my problems is a desk cluttered with notes and calendars and scraps of paper, and I can never find my address book when I want it. Getting all that on line would be worth something. True, I don't use an IBM PC to write with, but that's a solvable problem: within weeks we'll have the Compupro 8085/8088 sufficiently PC-compatible to run that sort of program, or at least they keep telling me we will. Besides, even if I don't end up using it because I'm not willing to convert to the PC as my personal machine, others here could, and I've plenty of friends who *do* use PCs and PC clones.

Alas, it's not quite all I'd hoped for.

As far as I can tell, Desk Organizer does do all it promises; but it does it *very* slowly, and it's more complex to learn and use than I would have thought. The complexity isn't a real barrier. There's an excellent tutorial, perhaps a bit cumbersome, but complete enough.

On the other hand, the version the company sent me didn't do what it said it would. In particular, the documents say that various items will be "highlighted," which I suppose means that they'll appear in reverse video. I had to suppose it, because it didn't; there was no hint of any highlighting when I used the program, which made it quite difficult to be certain precisely what the program was going to do; the control scheme involves using the arrow keys to move the highlighting up and down within a list; if there's no highlighting, you've no choice but to try to set things up so the top or bottom item in the list is the one selected. This was hard enough work that I soon abandoned it.

However, just this morning a new disk arrived from Conceptual Instruments. I had Peter put it into the machine, and it does come up with highlighted (boldfaced, not reverse video) items, so I suppose I had a broken copy. Alas, I haven't had a chance to check for speed improvements.

To Conceptual Instruments' credit, neither the program disk nor the data disks are copy-protected; in fact, there's a copy utility built into Desk Organizer, which figures, since you boot up the machine with Desk Organizer's operating system rather than the one that comes with the IBM PC. On the other hand, it took 4 minutes to format a disk, and after it was formatted, *11 minutes more* to copy the program disk. Conceptual Instruments may have discovered a new antipiracy scheme: terminal boredom.

Providing technical support is a job few computer companies enjoy.

Using the program is a bit like using Valdocs on the Epson QX-10: it works, but it takes so long that after a while you don't really care. There seems to be a lot of disk accessing. I don't suppose there's any help for it, given the amount of functions it performs and the data it stores. It could be unfamiliarity with the program, but I find it easier to hunt up my missing address book and look up the number.

There are nice features to Desk Organizer. The calculator is complete and fairly easy to use. There's a long section on "personalizing" the program. If you have the right kind of modem, the system will dial telephone numbers for you. There's a way to define the function keys as "stamps"; they could include your name and address, or the word CONFIDENTIAL, or indeed most anything you might have made into a rubber stamp.

In other words, I have mixed emotions about this program. I'd really like it to work, but I find trying to learn it a frustrating experience. Apparently I had a broken copy, since the manual is explicit about highlighting, and I saw no signs of it; moreover, from the serial number it was a very early copy. Perhaps the later version is speedier. If so, you'll hear about it. Meanwhile, if you're thinking about buying it, I'd advise you to get a demonstration from a dealer you trust.

The Technical-Support Dilemma

When the micro revolution first began, there weren't very many of us users. Most companies—hardware and software alike—were so small that typically there weren't any people specially assigned to answering customers' questions and solving their problems. The regular technical staff did that in their spare time. As an example, when some years ago I had a problem with Sorcim's Pascal/M compiler, Richard Frank, the president of the company, took the call.

That's pretty unlikely now. Any successful company sells thousands to tens of thousands of copies of its product, whether it be a computer or a program or, increasingly, both. Outfits like Digital Research, with many different versions of dozens of languages and compilers as well as the CP/M operating system, find they need large staffs to answer customer queries.

Providing technical support is an onerous job that few computer people enjoy. How could they? They're likely to get the same questions over and over again. An interesting question almost by definition means one they can't answer. Meanwhile, there are the dozens of callers, some asking superbly stupid questions, some with legitimate beefs, some irate, and nearly all unhappy. Anyone smart enough to answer the tough questions could be doing independent programming work, or, turning it around, in general if you don't know enough about computers to be doing development work, you probably shouldn't be answering users' questions. This makes for a vicious circle and a high turnover in the technical-support departments of many large micro suppliers.

On the other hand, there have to be technical-support people. Most microcomputer programs are not well designed and often have really poor documentation to boot. There's often no way to make the program run without correcting it and no way to tell the customer how to correct an older version except through direct telephone contact.

The expense of providing technical support is often used as justification

for high software prices. I'm fond of telling programmers that it takes at least as much time and effort to write a novel as it does to write a big program; but we don't charge hundreds of dollars a copy for novels. The almost inevitable answer has been that novelists don't have to answer many telephone calls about their characters and plots.

Digital Research's Technical-Support System

I've had mixed reports about Digital Research's technical support. Some readers are enthusiasts. Others have horror stories. I suspect it has to do with whom they talked to at DR, and how long that technician had been on the support assignment, and quite possibly the time of day. I know I've had a variety of experiences talking with them.

Last week I was working on my silly Star Trek game. As an aside: my apologies to those who ordered the darned thing from Workman. Barry kept after me to get the final version out, but I kept wanting to add yet another feature, and eventually Barry had piles of orders and was getting frantic just as I had other deadlines and the Christmas holidays were nearly upon us—but when I assembled the thing, it would run fine on my big systems, but it used too much memory for most machines.

The game is written in Compiling CBASIC, which has the ability to do overlays and pass variables from one section of the program to another by use of COMMON declarations. This seemed ideally suited for my game: I could do the setup in one section of the program, then call in an overlay for the actual play of the game.

Alas, the DR documentation on how to use COMMON and the overlay feature with array variables is not precisely a model of clarity. Still in all, I puzzled out what I thought was meant and tried it.

The setup worked fine, but as soon as it called the overlay it blew up in a spectacular manner: suddenly there appeared on the screen a bunch of garbage that included not only control characters and random stuff, but also the text of every string in the program, including not only messages but the prompts and error messages from functions. Disconcerting to say the least.

Logical analysis: either I was doing something wrong in the game itself, implementing the overlay feature improperly, or trying to do something that Compiling CBASIC can't do. Of course, we were in a hurry: there were my deadlines, and Mrs. Workman was unhappy because customers were calling about this stupid game. I needed a shortcut.

The simplest thing would be to eliminate one or more of the possibilities, and the easiest way to do that would be to call Digital Research. If I had assurance that Compiling CBASIC would do the job, then I'd be miles ahead, even if there wasn't anyone there able to tell me precisely how to do it; and if Compiling CBASIC wouldn't, then I could stop wasting time trying.

It used to be when I had questions about CBASIC I'd call Gordon Eubanks. After all, he wrote the program. Gordon, however, has set off on his own to produce some new software, so that wasn't an option. There was nothing for it, then, but to call the DR switchboard.

The result was weird. First, someone asked me if I were an end user. I could tell it wasn't a casual question. "As opposed to what?" I asked. "I write a software review column called The User's Column, so I suppose I am." Long silence, then I was shunted to another telephone. And another. I kept saying, with rising impatience, "Look, all I want to know is whether Compiling CBASIC can do this. I don't even need to know how, just whether I'm wasting my time trying." I must have said that 10 times. Eventually I tired of it and asked for the director of press relations, only to be told DR doesn't have one, and I should talk to a PR firm in Palo Alto. Then I was put on hold again, and another voice came on. This one told me her name was Mary Anne Brown, and I needed another person named Brown from a different department, and she'd try to get the other department for me.

By this time I'd been on the phone

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P1340

For considerably less, the new P1340 gives you just a little less. But it still has the same high-density 24-pin dot-matrix print head, the 180 x 180 dots-per-inch graphics resolution, and the Qume SPRINT 5 emulation. In addition to true proportional spacing and a built-in forms tractor. Whichever printer you choose, you also get nationwide service within 24 hours by Western Union technicians.

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For more information, call toll-free: **1-800-457-7777**, Operator 32. Or call one of the distributors listed on the adjacent page.

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In Touch with Tomorrow

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Information Systems Division, **TOSHIBA AMERICA, INC.**

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to DR for half an hour, and I'm certain I was neither civil nor coherent, and I want to commend Ms. Brown for her patience. In the unlikely event that Digital ever lets her go, she could get a job with the State Department anytime. Alas, it did no good: the other department would not speak to me; and there matters rested.

The next day Digital called me. It seems to have been changing its technical-support setup, and between the changes and the impending holidays the system wasn't properly implemented, and I'd fallen between the cracks.

The new system is—well, before I express an opinion, I'll describe it.

DR has a new "Technical-Support Program for the Professional Programmer." Actually, it's not all that new; but I'd never heard of it, probably because in the past I'd always called program authors directly. Anyway, the program costs $250 a year and entitles you to:

- a toll-free phone number to DR
- unlimited calls on that number regarding all DR products
- written software performance reports
- access to Microline, a DR support service on The Source
- free hookup fee to The Source
- a new quarterly technical newsletter

That's the theory, anyway. In practice, you apply by signing a form acknowledging that DR "does not guarantee support service results" and it denies "all expressed and implied warranties, including all implied warranties of merchantability and fitness for a particular purpose." In addition, you must (not unreasonably) be shown to be a valid owner of the software to be supported under the agreement. DR doesn't say what it will do if you sign up for the service and subsequently buy something else from it, but since it says the single fee entitles you to support for all the DR products you've bought, I presume it will cover the new ones when you get them.

DR says that there is still some free support for end users. That, however, is provided by an entirely different department of "generalists." The professional technical-support people are specialists, and they will talk to you only if you call on the (unlisted) toll-free technical-support line, which is why Ms. Brown couldn't get anyone to take my call. She should have referred me to the end-user support group. It was implied that if I'd clearly stated that I was an end user, I'd have gotten to someone who could answer my question.

That may be. On the other hand, I've heard complaints from end users who say that the generalists can't answer many questions. A few of my correspondents are hopping mad: they're sure DR has let them down.

I have mixed feelings.

First: DR has always been one of the leaders in providing support for its products. Its generalists in the free support department can still provide better support than is customary in the micro industry.

Second: as I said when I began this, technical support is a tough

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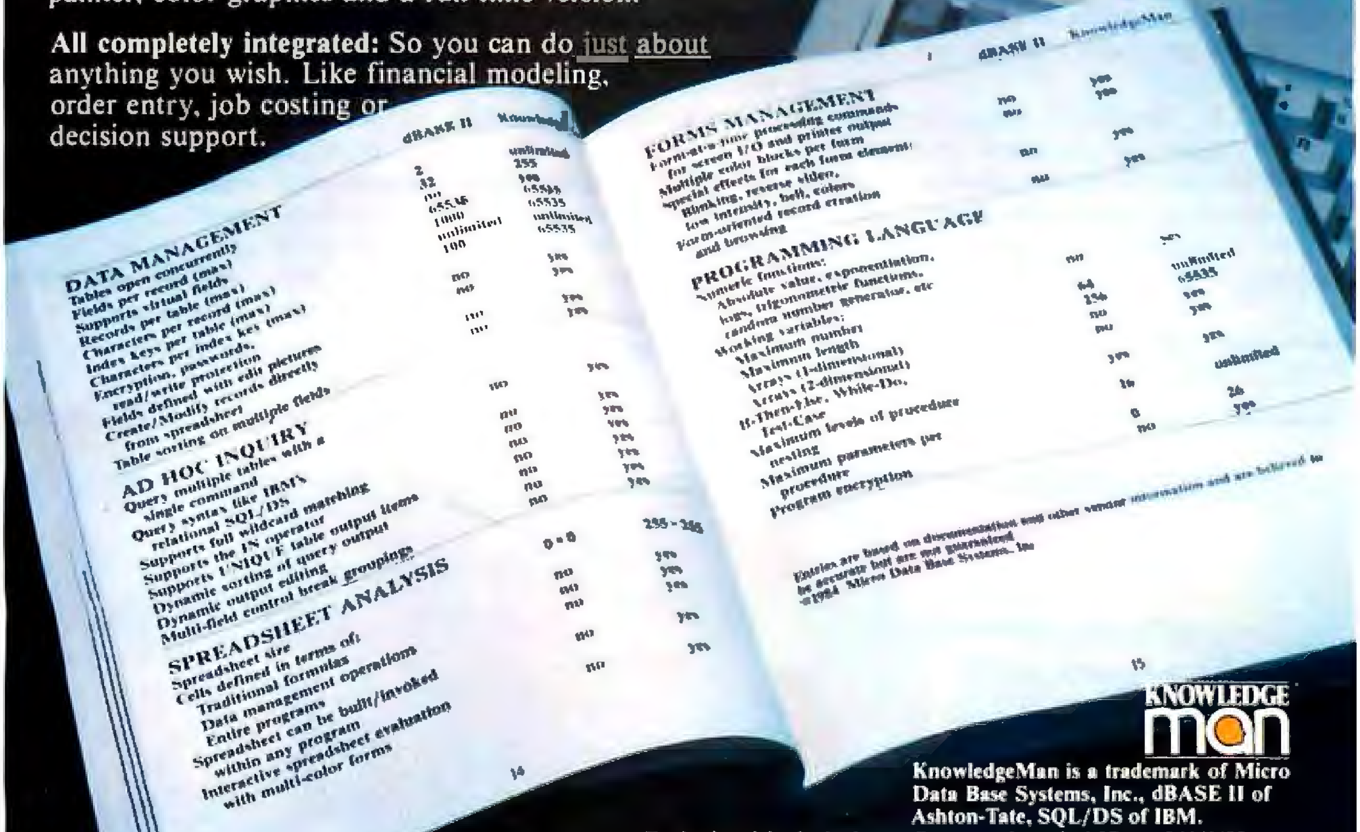

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problem, and as the number of micro users grows, it's going to get worse, not better. A "Professional Technical-Support Service" is much needed, and DR should be applauded for providing it.

Third: the end user has been harmed by this move, but it's difficult to see what can be done about it. Once again: there are just too many customers, with too many questions, and it's cruel and unusual punishment to require highly skilled computer professionals to man phones in order to answer the same silly questions over and over again. I don't think my own question was silly, but a case can be made for that view; and many of the questions they get are genuinely stupid.

Fourth: it's particularly sticky to provide support for compilers, because there are so many different things people try to do with them, and thus so many ways for things to go wrong.

Knowledge Brokers?

One possible solution: form independent technical-support organizations. Alex suggested that a bright young entrepreneur might make a pretty good living advertising full support for DR products at $100 a year. After all, such a third-party service has popped up for Kaypros; why not software? With enough customers, the charge might be even less than $100 yearly. Naturally, one expense would be a subscription to the DR Professional Technical-Support Program. For DR products, our entrepreneur would be in effect a knowledge broker: tough questions would be referred to DR.

Indeed, this might work to DR's advantage, since the knowledge broker would filter out both silly questions and repetitive questions and bring only fresh new problems to the DR staff.

Of course, there's a radical solution: better software and *much* better documentation, so that the questions are answered before the customer buys the product. No one seems to have thought of that one, though.

What Was Really Wrong

As to my specific problem, Compiling CBASIC can indeed pass array variables in COMMON, and there aren't any restrictions on declarations and functions, either. It turns out that what I had done, alas, was miscopy my Dimension block, so that I had an undimensioned variable. The Compiling CBASIC compiler will not catch this error (see the January User's Column, page 80, for details). There's no run-time error either. The computer just gets lost, producing totally unpredictable results.

That's what had happened to me: the undimensioned array had managed to send the program off into a data area, so it tried to interpret data as program instructions, with disastrous results.

CBASIC used to catch "undimensioned array" errors during compilation. It also caught "subscript out of range" errors at run time. The first version of the compiler for CBASIC was totally compatible with CBASIC2, meaning that you could compile the programs under

Text continued on page 74

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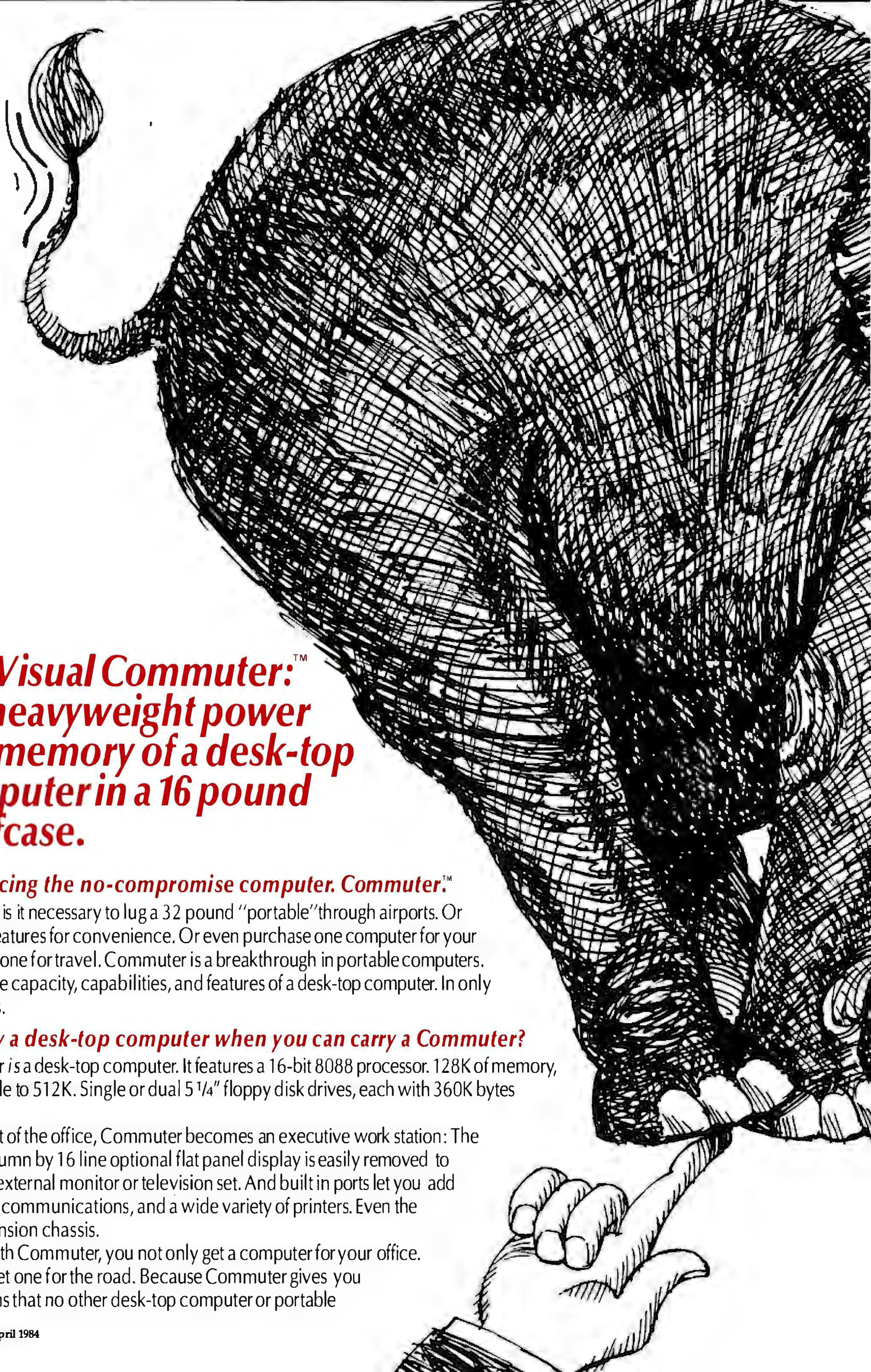

Text continued from page 70:

CBASIC2 and run them for logic checkout; if everything worked, use the CB80 compiler to produce fast-running machine language. The CBASIC2 version, being interpreted, would be slow, but because of its range checking the debugging was easier.

I discussed this with Richard Lovelace, a supervisor in the DR technical-support division. "What we need," I said, "is to upgrade CBASIC2 so that it will accept the full Compiling CBASIC structures and functions. Then we can use the CBASIC2 pseudocompiler for checkout and debugging."

He allowed as how that was probably a good idea, but there wasn't much enthusiasm behind it. DR tells me that it is working on the problem, but I haven't found out what it is planning.

Oh, well. Let it be a lesson to me. The lesson is: use languages in which *the compiler* catches the errors; that way you won't be so baffled if the program doesn't work.

Databases

It's amazing how many outfits offer information nowadays. You can get on-line data on everything from horse breeds to agricultural production. The only problem is figuring out who has what information for sale and how to get at it.

Owen Davies and Mike Edelhart have published a book that will help. The *Omni Online Database Directory* (Macmillan, 1983) gives information on more than 1000 databases that you can access with a terminal and modem. The book covers everything from Compuserve and The Source to a database on wine selection. I doubt anyone would find the book interesting light reading, but it's sure a handy reference. It's also well written, with clear instructions on how to access the various information sources.

The $19.95 hardback is a bit overpriced; get the $10.95 trade paper edition. It's just as useful and will last as long as the information in it.

Incidentally, Owen Davies is doing another Omni book, this time on small computers. I'm doing a short piece, Alex is reviewing some computers, and Barry Workman is doing a review of the Lobo Max-80. It ought to be out toward the end of 1984.

What's Right with Borland

Borland International sells a full-feature Pascal that looks to be at least as useful as Digital Research's Pascal MT+; I've heard reports that it's faster and more compact. I'm having Marty Massoglia check that out for the IBM PC 16-bit version. I know the Z80 version is darned good because we used it to compile some chunks of the Galactic Traders game I'm writing.

The only thing I've got against Borland is the name "Turbo Pascal," and I suppose I can survive that. At $49.95 ($149.95 if you want to sell products compiled with Turbo Pascal), it's one of the best deals in town.

Borland's president, Philippe Kahn, tells me the company has only one real problem: people confuse it with JRT Pascal, and since JRT had real distribution problems, potential customers wonder if they'll have the same difficulty with Turbo Pascal. "How," he asked, "can I convince people that I'm shipping the same day orders come in?" He even offered to fly me up to his location to inspect the facilities.

I didn't have time to do that, but I find the offer itself interesting. I can also say that I've heard no complaints about Borland, and people are usually pretty quick to write me if they feel they've been ripped off. I find Borland's package pretty impressive. The company also provides technical support by telephone.

It's about time for micro software prices to come down to reasonable levels. To the best of my knowledge, Borland's Turbo Pascal is a giant step in the right direction.

CP/M for Z-DOS

Walt Bilofsky's Software Toolworks has produced yet another useful program. It's called ZP/SIM, and it will run regular CP/M 8-bit programs under 16-bit Z-DOS. That's the good news.

The bad news is that it won't run *all* CP/M programs under Z-DOS,

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- Coded in C language
- Base color support

Standard Features-CLEO 3780

- Point-to-point and multipoint communications
- Available for CP/M™, MP/M™, MsDOS™, TurboDOS™, Unix™, and Xenix™
- Also supports transparent mode
- Coded in C language

CLEO

and unless you're a better programmer than I am, there's no way to infer from the Toolworks documents just which program *won't* run with it. We know that WRITE won't work with it. That's hardly surprising, since WRITE uses some very sophisticated tricks to get sorted directories and disk-file sizes and such.

On the good side again, ZP/SIM is easy to use, and the documentation is plenty good enough to get it running. The complexities come when you're trying to figure out what will and won't work under ZP/SIM; the simple solution to that is to try it and see.

This program would be useful to any Z-100 owner who has Z-DOS, doesn't care to buy the CP/M-85 package, and wants to run fairly simple 8-bit CP/M software on the machine.

That may be a limited market; but as I've said before, every Z-100 owner ought to know about Software Toolworks. Walt has some of the best software bargains in this business.

SIG/M

There's a lot of good free software out there, including, I'm told, a good Pascal interpreter. (I don't know whether it's the mystical public-domain UCSD Pascal they told me about at Cornell.)

Anyway, I've just been sent the latest SIG/M (Special Interest Group for Microcomputers) catalog that describes about 100 disks full of public-domain software. There are games, mailing-list maintainers, modem programs, tests for the Compupro Clock Board, ZCPR (a new command processor to substitute for CP/M's on systems using a Z80 chip), and myriads of other programs. There are Help programs, assembly-language macros, a LISP written in Pascal, calendars, things to set the margins for a Diablo printer, an editor to use for writing programs in the C language—well, you get the idea. There's just a ton of stuff.

Understand, there are no guarantees. Some of this free software is useful, but some is guaranteed to be boring. Also, the quality of this stuff varies enormously. Most of the pro-

Circle 236 on inquiry card.

grams by Ward Christensen (a famous public benefactor) are very good to excellent, but some of the SIG/M programs are loaded with bugs. Moreover, much of it duplicates stuff available from the CP/M User's Group; but SIG/M charges significantly less per disk.

Incidentally, many of the programs offered by SIG/M are sold commercially. This specifically includes an "Unerase" utility that will restore erased files and a "Find Bad Sector" program that locks out bad disk sectors.

Many, but certainly not all, of the most useful of these programs (including Findbad and Unerase) are marketed by Workman and Associates. Workman adds a few programs from other sources and sometimes cleans up the documents; his four utility disks include programs selected from about 25 of the SIG/M disks.

The SIG/M catalog is $3 mailed in the U.S. and $4 to a foreign country. Program collectors and software addicts can't afford to be without it, and anyone seriously interested in getting the most out of a microcomputer will probably find it interesting.

Carry Me Away

One permanent new addition to the menagerie at Chaos Manor is the MPI Sprinter, which is a completely portable version of the Printmate 99 dot-matrix printer. Actually, it's somewhat more advanced than the model 99 in that there are provisions for a memory buffer card and some other features. Like all the MPI products we've tried, it's easy to set up, works fine, and produces an acceptable grade of dot-matrix print, not quite up to letter quality, but good enough for almost any reasonable purpose.

The main thing the Sprinter has going for it, though, is that it's *really* portable. It closes up in its own case. That case has room for some paper and manuals and all the cords and cables it needs. Once closed you can take it to the airport and send it as checked luggage. If sending it bare frightens you, there's also a black ballistic nylon outer carrying case with pockets and shoulder strap.

Getting the Sprinter hooked up was a snap: we uncrated it, connected it to the parallel printer port on the IBM PC, and turned both machines on. It worked. You can also get a serial interface for it.

I recommend it for anyone who needs a portable printer. It's a nearly ideal companion for an Otrona Attache. Mrs. Pournelle takes the Otrona and the Sprinter to meetings of the LA County Schools Micro Computer committee. I do much the same at shows, and meetings of the L-5 Society Board of Directors, and such like. The Otrona is unobtrusive while I make notes, and the Sprinter gives hard copy on the spot.

Ye Gods . . .

Every month, I start this column wondering if there'll be enough to talk about. I make lists of topics and begin to write, and as I write things happen: phones ring, letters come, one of the staff has a bright idea, and each interruption generates another topic to write about.

The result is that I never get to finish the list I began with. I'd intended to say something about iAPX186 machines in general and the Slicer "no-frills hacker special" in particular (it's a good deal if you know hardware and like tinkering); the computer literacy controversy; the imbecilic notion that small computers are going to make poor people even poorer; the new TMX 8/16 BIOS for Compupro 8085/8088 Dual Processor machines (speeds disk operations up by a factor of two); and the Game of the Month, which seems to be Wavy Navy by Sirius Software.

Alas, I'm out of space. At least I don't have any problem finding topics to write about.■

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

Jerry Pournelle welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE Publications, POB 372, Hancock, NH 03449. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply.

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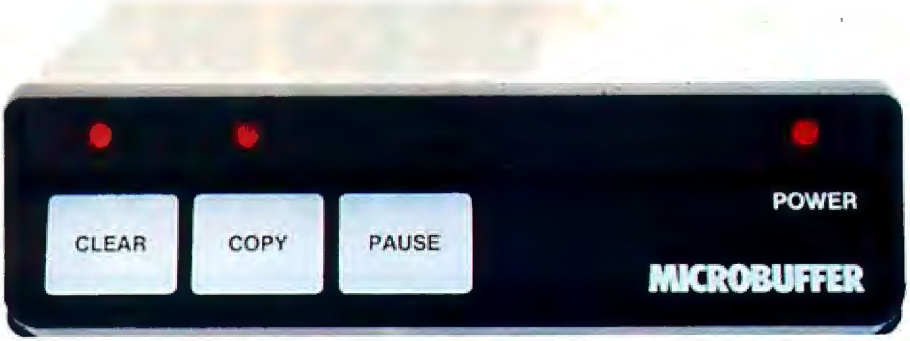

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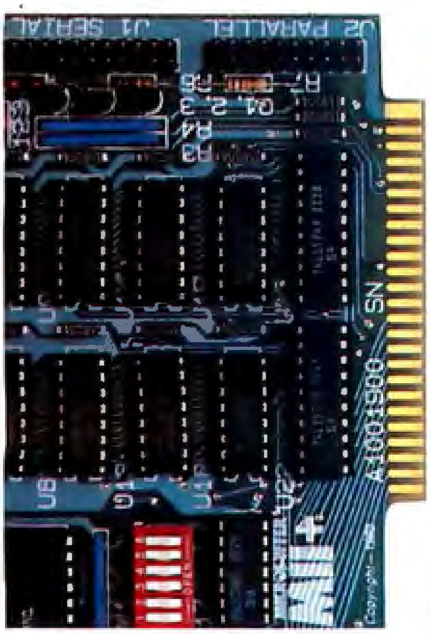

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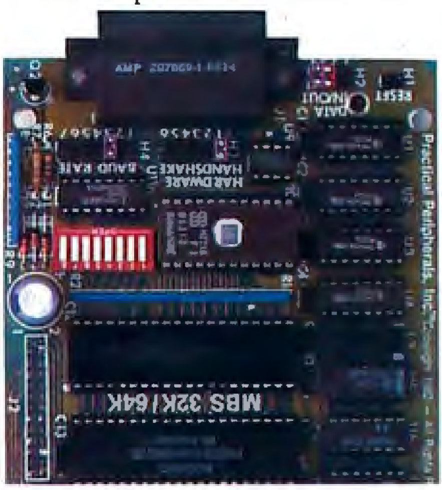

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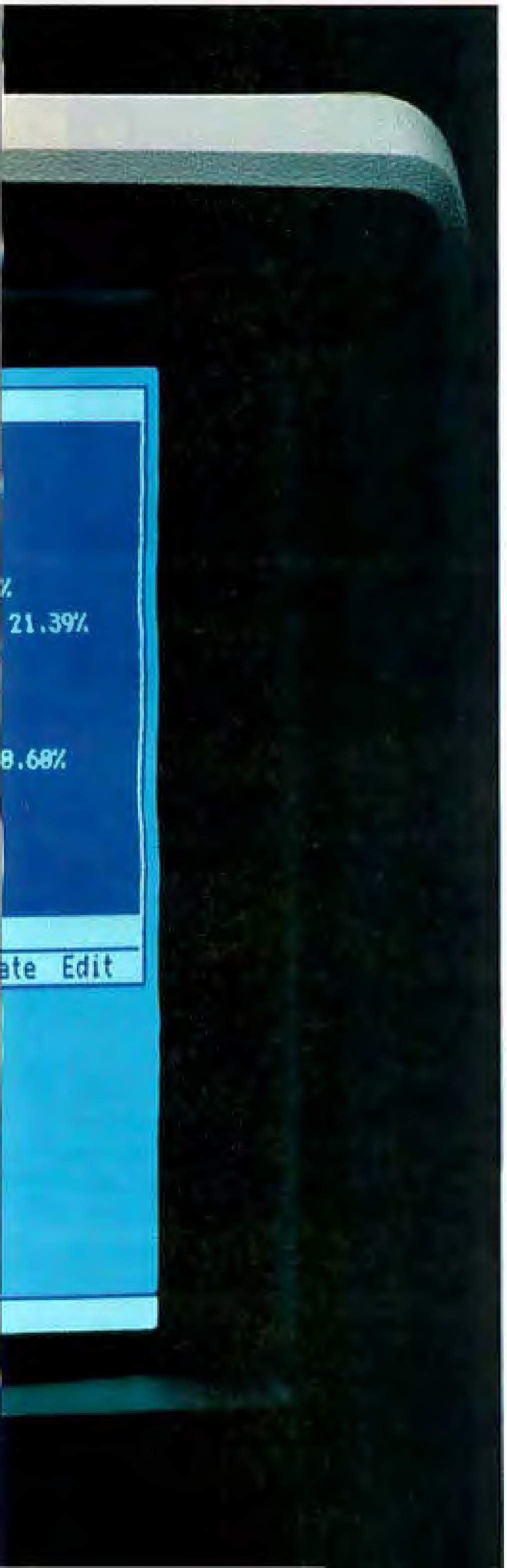

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William T. Coleman, VisiCorp's Director of Product Development

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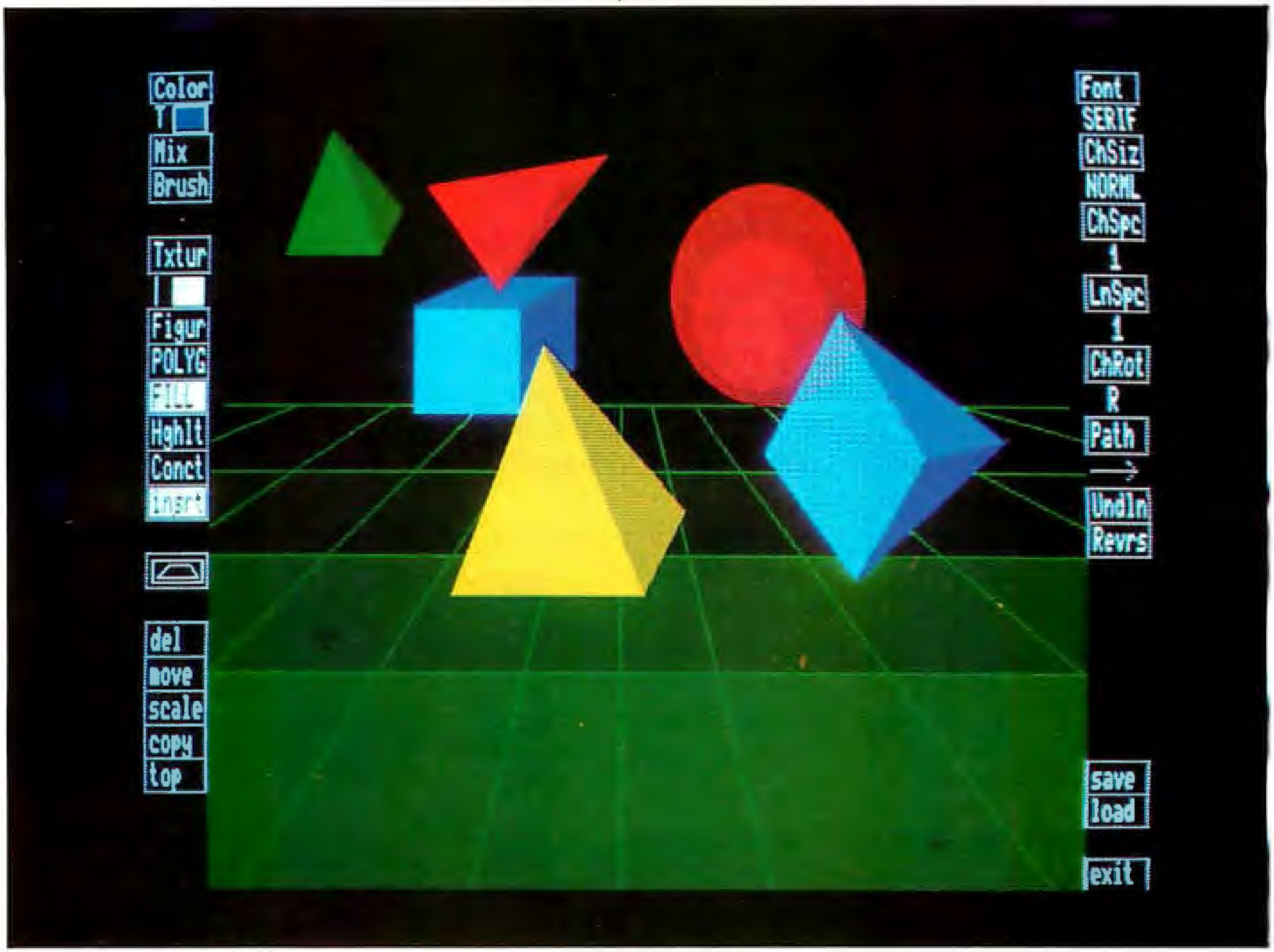

Photo 1: *A high-resolution display on the Verticom terminal with editing menus at the edges of the screen.*

Stylish Output

Graphics terminals and a quiet ink-jet printer

Ezra Shapiro
BYTE Technical Editor

The Verticom PLP100 and PLP200 NAPLPS-compatible (North American Presentation-Level-Protocol Syntax) color graphics terminals are designed for both the creation of videotex and applications in CAD (computer-aided design). As such, they are not really average consumer devices. However, the relatively low price tag ($6450 for the PLP200 and $5650 for the PLP100, a stripped-down version) puts sophisticated graphics-generation potential into the hands of an audience that can't afford the tens of thousands of dollars typically required for equivalent systems. A basic installation, including the PLP200 terminal (high-resolution 13-inch RGB (red-green-blue) monitor, independent controller box with Multibus expansion slots, and Keytronic keyboard), an IBM PC XT computer (or clone) for data manipulation and storage, either an optical mouse or a digitizing tablet, and interactive software, sells for around $15,000-not cheap, but well within the range of affordable single-user prices.

Hardware

The guts of the Verticom terminals are based around twin Zilog Z80s controlling 320K bytes of dual-port display memory, with 2K bytes of CMOS (complementary metal-oxide semiconductor) RAM (random-access read/write memory) with battery backup. Both units come with a Centronics-compatible parallel printer port and an RS-232C serial port for data transfer. The display monitor is capable of 640- by 480-pixel (picture element) resolution (more than double that of the IBM PC) with 16 colors displayable at one time, selected from a palette of 4096. On-line RAM can hold two pages of graphics, enabling simultaneous output of one page and the creation of another. Both devices can emulate DEC VT-100 and Tektronix 4010 terminals, support full NAPLPS coding, and operate in a mixed NAPLPS/VT-100 mode. A 19-inch monitor, light pen, and 32-bit parallel-port access to the display processor are options for either machine. Options for the PLP100 that are standard on the PLP200 include a second serial port for use with a mouse or other input device, integer zoom and panning, and firmware for page creation. Multibus expansion and host-resident software are optional for the PLP200, unavailable for the PLP100.

The Verticom terminals are among the first to adhere strictly to the proposed NAPLPS standards. NAPLPS, endorsed by some 20 manufacturers, including the major videotex producers, is a hardware-independent coding standard that lets you mix text and graphics in a compact ASCII (American National Standard Code for Information Interchange) data file suitable for easy transmission. NAPLPS supports a wide range of graphics primitive commands (draw a circle, fill an area with color, etc.) and a dynamically redefinable character set. The major purpose of NAPLPS is to establish a convention for display data that will enable videotex to be received on a wide variety of computers and terminals, regardless of monitor size and resolution. For a brief introduction to NAPLPS, see "NAPLPS Standard Graphics and the Microcomputer" by Leo Lax and Mark Olsen in the July 1983 BYTE, page 82. Greater detail can be found in "NAPLPS: A New Standard for Text and Graphics" by Jim Fleming and William Frezza in the February through May 1983 issues of BYTE.

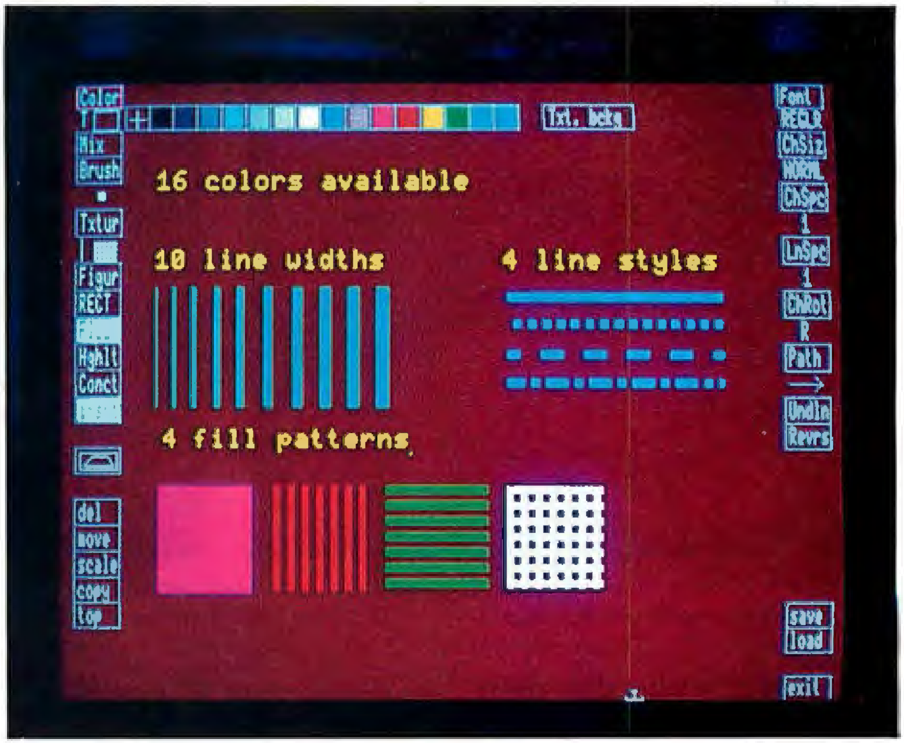

Photo 2: *A demonstration of Frame Editor's available attributes for constructing videotex and CAD screens. The menu strip across the top shows 16 color possibilities.*

Software

Using Verticom's software package, Frame Editor, on a host computer (currently supported: the IBM PC XT, DEC VAX, Plexus, and Onyx) linked to the PLP200, it's possible to generate full-screen graphics at remarkably high speed. The hardware can fill areas with color at a rate of 800 nanoseconds per pixel—and that's *fast*. The color possibilities are impressive, too. Although only 16 colors can be on line at one time, you have 4096 choices. You can create or modify colors by adjusting percentages of red, green, and blue from 0 to 100 percent in 7 percent steps. Future versions of the program will support an alternate selection process. You'll be able to determine color by varying hue, saturation, and intensity. Either way, you can produce frames that seem to allow a wider range of colors than the 16 on line. Three-dimensional shading effects can be simulated quite effectively. Of course, starting a new screen reopens the selection process, and variation from screen to screen can be dazzling.

You select your drawing options from a simple menu that appears on the left and right edges of the screen. Choices that require further input, such as color selection, lead to menu strips across the screen that disappear as soon as you choose your answer. Four line styles, 11 brush widths, and four area-fill patterns are available. Lines, arcs, circles, rectangles, and polygons can be drawn singly or connected to each other. Using the connected-arc primitive, you can construct flexible curves with multiple radii. What are known as "rubber boxes" can be drawn around objects or groups of objects; the items enclosed can be moved or copied to a new cursor position, exploded or collapsed in scale, deleted, or brought to the top level of the display. At the time this article was written, neither freehand drawing (vital for fine arts and videotex applications) nor a snap grid was implemented, although Verticom's software engineers promised both features soon. (Snap grid is an important element in precision CAD packages, a stan-

(3a) (3b)

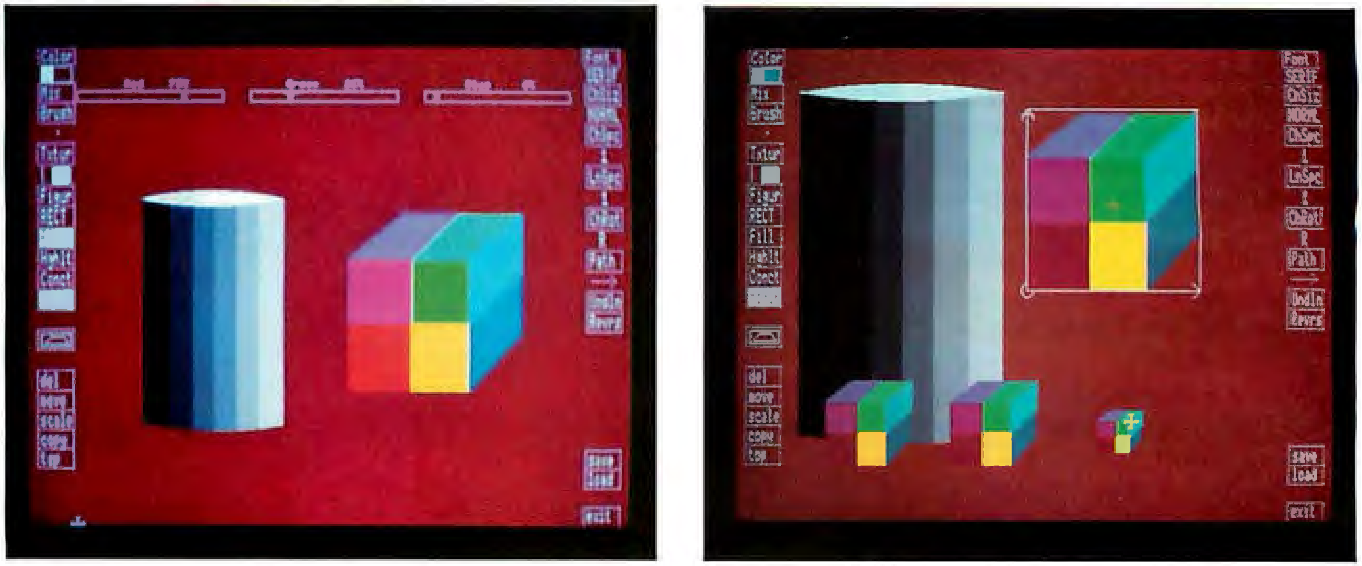

Photo 3: *Object-oriented graphics flexibility is an integral part of the Frame Editor concept. Using "rubber boxes," the two objects in 3a have been resized, copied, or moved to produce 3b. The menu strip at the top of 3b is Frame Editor's RGB color-mixing menu.*

dard graphics scheme that allows lines and objects placed approximately to be moved—snapped—to points in a fixed coordinate system.)

Text can be added to displays in three fonts or a "mosaic" font of block graphics symbols. It can run left to right, top to bottom, bottom to top, or upside down right to left. Character size, character spacing, and line spacing are all variable.

A second approach offered by Verticom is a selection of FORTRAN-based subroutines that can be used by programmers to gain access to all NAPLPS primitives without the use of a virtual editor such as Frame Editor.

In either case, the host computer is used to store the NAPLPS picture databases, which can be sent to any terminal employing the NAPLPS protocol.

Conclusions

William Chu, president and chief executive officer of Verticom, comments that the use of graphics will increase dramatically over the next few years as both videotex and NAPLPS gain wider acceptance. He sees the two terminals as a first step in the right direction. As people begin to explore the world of computer graphics, costs will come down and applications will multiply.

In the meantime, products such as the PLP100 and PLP200 will serve as the testing ground for graphics at a reasonable price.

The HP 2225 Printer

If you've been longing for a dot-matrix printer that costs less than $500 and doesn't sound like an extremely painful visit to the dentist, the HP 2225, to be marketed as Thinkjet, may well be for you. The first thing you'll notice about this new ink-jet printer from Hewlett-Packard is that it's amazingly *quiet*. It's also compact (somewhat smaller than a metropolitan phone directory), good looking, and well engineered. In many respects, it marks a real technological breakthrough in personal printers.

The HP 2225 is a bidirectional, logic-seeking, dot-matrix printer that runs at 150 cps (characters per second) and operates at a noise level below 50 decibels (dB). It can handle either standard single sheets of letter-size stationery or the equivalent pin-feed, fanfold computer paper. Interfaces available include the common Centronics-style parallel interface (making the HP 2225 compatible with most personal computers on the market) or one of two HP proprietary interfaces for use with Hewlett-Packard products. All three models come with a 1K-byte buffer.

Print quality is equal to or better than that of impact dot-matrix printers in the same price bracket. Though it's possible to identify the HP 2225's output as coming from a dot-matrix printer, the dots are tightly spaced and the characters well drawn; copy is extremely easy to read. The character set is produced using a matrix of 11 by 12 dots in four pitches: normal (80 characters/line), compressed (142 characters/line), expanded (40 characters/line), and expanded compressed (71 characters/line). Eleven foreign-language character sets are user-selectable. Boldface and underlining controls eliminate the need for a second pass of the print head. Two dot-addressable graphics modes, at resolutions of 96 by 96 and 192 by 96 dots per inch, provide adequate capabilities for most types of business graphics.

The unit measures 11.5 inches wide, 8.1 inches deep, and 3.5 inches high. Its weight of a mere 5½ pounds (6 with an optional nicad battery pack for an HP interface) makes it a truly portable full-featured printer. The size and weight can be kept so low because the HP 2225 does not have to withstand the constant pounding of an impact printer; the only thing that touches the surface of the paper is ink. Other than the paper-feed mechanism, the only moving parts of the unit are in the print-head carrier that glides back and forth across the width of the carriage. Another benefit of this arrangement is the printer's tiny power consumption

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Photo 4: *The Hewlett-Packard 2225 ink-jet printer. HP engineers claim a noise level below 50 decibels—quieter than normal conversation.*

(less than 20 watts), which won't have much of an effect on your monthly electric bill, but makes a significant difference in the effective life of a charge of the battery-powered unit, which Hewlett-Packard rates at approximately 200 pages.

How It Works

The real touch of genius in the HP 2225 is the disposable print head, an object about the size of an oversize sewing thimble, that will sell for about $8. The company claims the head should be good for 500 pages of average output.

The outer casing of the print head contains a bladder that holds a liquid ink about the consistency of standard drawing ink. The shell is made of transparent plastic to allow visual monitoring of the remaining ink supply as the bladder collapses.

The front end of the unit consists of three pieces: the cap of the shell, a complex layer of thin-film material much like a semiconductor integrated circuit, and a glass plate with 12 holes representing a single column of printer dots. Ink fills a chamber above the film and is drawn into the holes in the plate by capillary action. Depending on the number of dots to be printed in a given column, resistors in the film directly beneath the appropriate holes are fed current, heating the ink above. The superheated ink forms gas bubbles that force the liquid ink held in the holes to burst out of the head onto the paper. At this point, the resistors have long since cooled and the gas bubbles have contracted. The holes that have been emptied draw more ink, the head advances, and the cycle is ready to begin again. The head is assembled as a negative-pressure environment; that way, ink will not leak from the holes unless stimulated.

Unlike most current ink-jet printers, the HP 2225 uses no tubes and no nozzles, reducing the chances of fatal clogging. In fact, Hewlett-Packard sees paper dust and other foreign matter as the major source of operational difficulties in the ink delivery system. The company suggests that a fast wipe with a clean cloth is all that will be needed to cure any problems. But to provide insurance that all 12 dots are firing, the printer blasts a column of dots into an absorbent pad to the left of the paper margin at start-up. The pad is replaced every time the print head is changed. In the worst possible case, a damaged print head can be thrown away and a new one installed for a fraction of the cost of a conventional fabric printer ribbon—and without the dirty fingers.

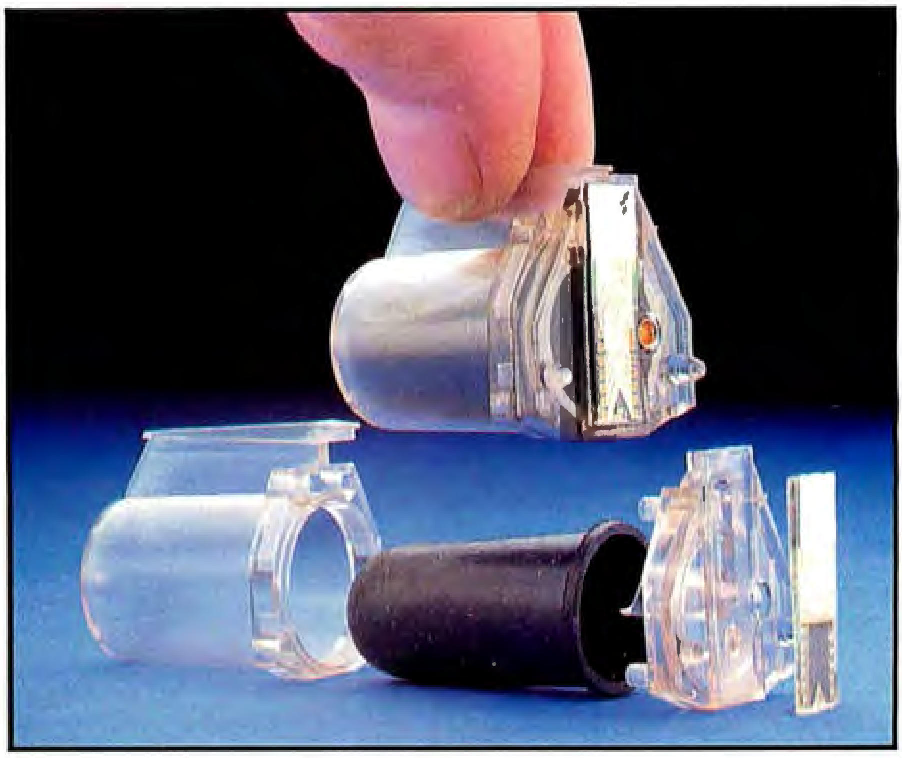

Photo 5: *The simplicity of the HP 2225's print head is evident in this disassembled view. All the technology for printing is contained in the thin-film strip at the right.*

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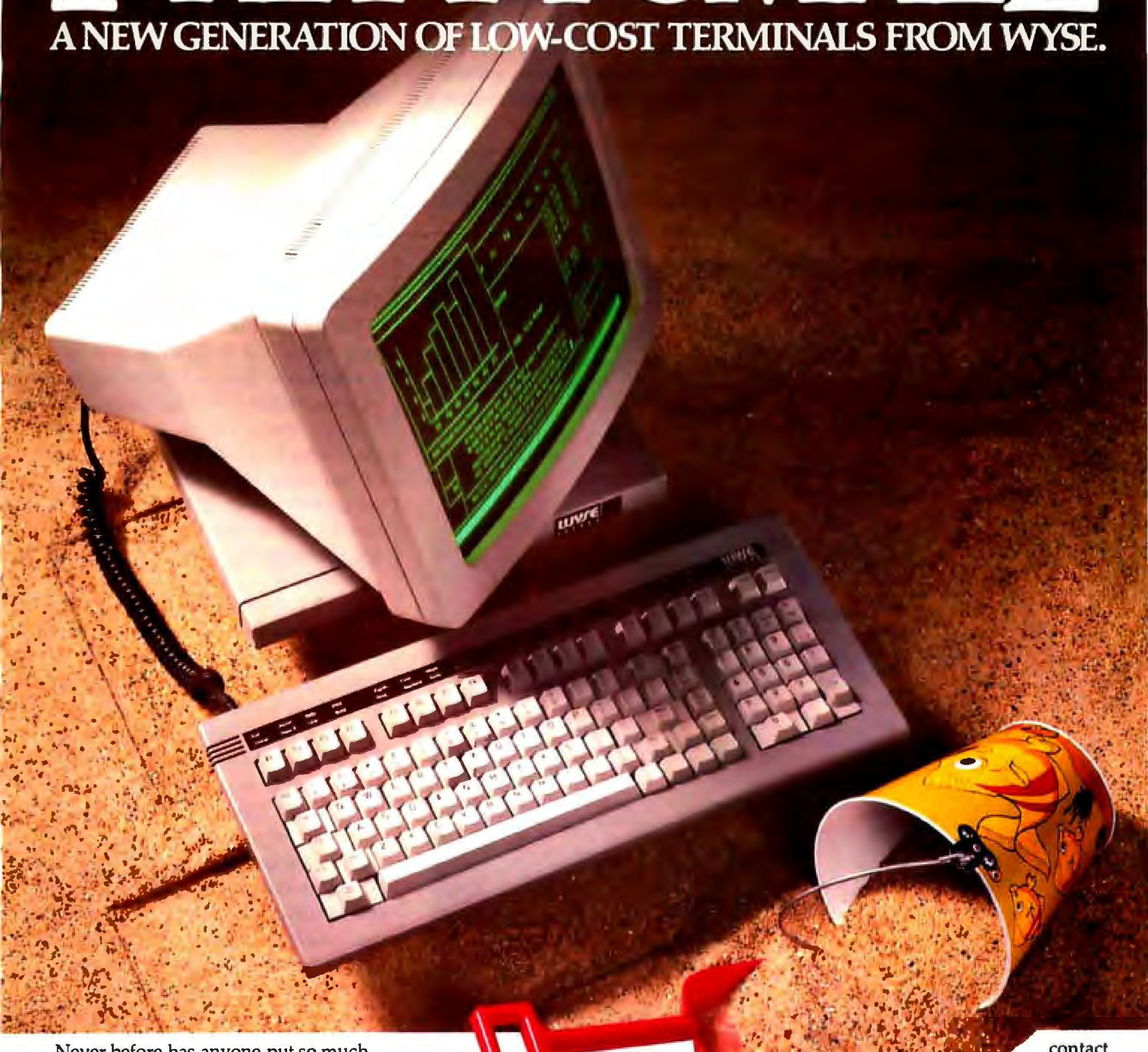

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The Paper Chase

The only major obstacle facing the HP 2225 is the availability of paper better suited to ink-jet technology than the current average computer stock. That's not to say that the 2225 won't print on standard paper; it most certainly will, although the acceptability of the printout is debatable.

Most of today's stock is made from relatively long fibers; the liquid ink that reaches the paper surface flows along these fibers until it is fully absorbed—the longer the fibers, the greater degree of fuzziness that appears around the edges of the dots that make up the characters. Manufacturers of high-resolution four-color ink-jet printers recommend expensive clay-coated paper—ink is absorbed by the clay rather than by the paper underneath. Because there are no fibers in the clay, the dots remain crisp.

Hewlett-Packard's engineers believe that its ink doesn't demand the luxury of clay and will print well on uncoated paper made from shorter fibers. The difference in cost between long- and short-fiber paper is almost negligible; the critical issue is availability in sufficient quantity to meet demand. Hewlett-Packard is working with paper manufacturers to ensure a good supply of appropriate stock, but it becomes something of a circular issue—sales of the printer depend on the availability of paper that depends on sales of the printer. But if the paper industry is willing to bet that the trend is toward ink-jet printers, as seems likely, this might be a moot question.

Conclusions

Public acceptance of the HP 2225 may signal the beginning of a new era in printer design. Competing ink-jet printers from Diablo, Canon, and Sharp, among others, are either in the works or the preliminary phases of shipping. And Hewlett-Packard concedes that the HP 2225 is the first step in a new technology, one that will undoubtedly be refined at a rapid pace over the course of the next few years. It is confident that the HP 2225 will be a success; it makes no bones about its intent to become a major producer of low-cost computer printers.

But perhaps the most cheering thing about the introduction of this printer, as it was last fall with the unveiling of the HP 150 touchscreen personal computer, is that a company known for a solid line of products aimed at engineers, scientists, and professionals can successfully invade the consumer market with startling, innovative technology and a refreshing attitude of independence.■

A Microman Update

In the February BYTE West Coast (page 148), I reported on the Microman integrated software package from Noumenon Corporation (512 Westline Dr., Alameda, CA 94501). Microman has been renamed Intuit and is currently being shipped.

Ezra Shapiro is a technical editor at BYTE's West Coast bureau. He can be reached at McGraw-Hill, 425 Battery St., San Francisco, CA 94111.

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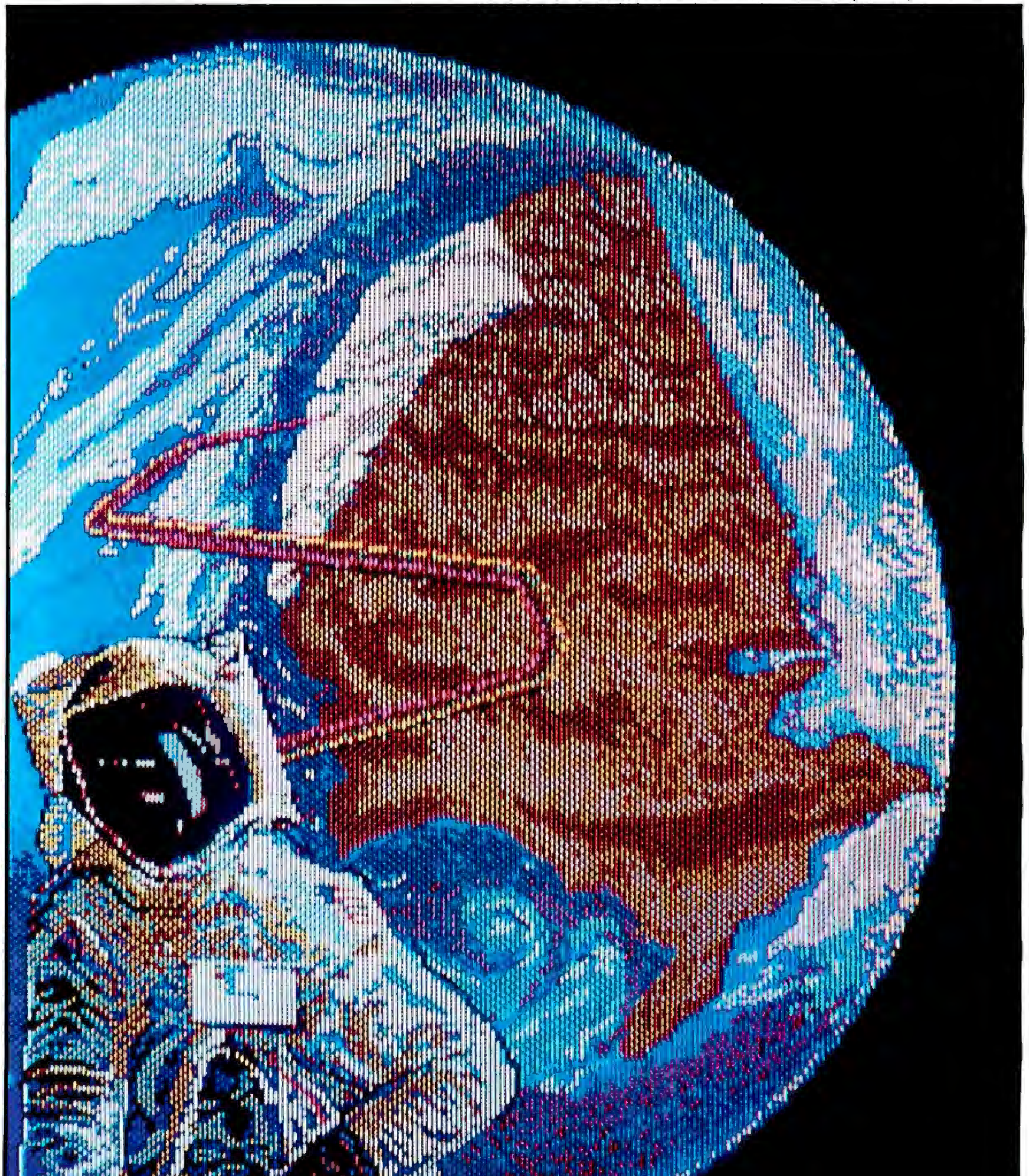
Graphics by Saul Bernstein



The World of Micros

Brush aside for the moment the excitement of the latest breakthrough in micro land and think back to your first exposure to a microcomputer. Among other things, you might have said, "That's kinda nifty, but what can I do with it?" If your memory goes back to the Altair and IMSAI days, you probably remember the alleged utility of all those front-panel toggle switches and LEDs. My first run-in with an IMSAI 8080 involved spending half an hour painstakingly toggling in a batch of (then) strange base-16 numbers and subsequently being told that the indecipherable (to me, at least) light pattern on the front panel did indeed display the correct "answer." I thought, "If this is all one of these things can do, then the 'real' computers don't have to worry about being replaced." Times have changed.

From sewing and driving an automobile, to sophisticated word processing and powerful number crunching, if a task can be done at all, there's a good chance that a microcomputer can do it. Minicomputer and mainframe power of a few years ago has moved into the workstations, offices, and homes of people around the world, and people everywhere are putting this power to work. Our theme articles for April include some theory, some system descriptions, and some projects that touch on the capabilities and perils of ongoing real-world interfacing.

For readers involved in systems development, "Personal Computer Signal Processing" by Bill Englemann and Mark Abraham from Analog Devices offers an introduction to some of the capabilities of today. For interfacing considerations, take a look at "Designing Systems for Real-Time Applications" by James Isaak of Charles River Data Systems and "Planning a Computerized Measurement System" by Craig R. Wyss. "Interfacing for Real-Time Control" by the technical staff at Fairborn Observatory shows how careful interface design simplified both hardware and software development in an astronomical environment and *includes* a discussion of several interfacing approaches. To round things out, we have part 1 of "Putting the Apple II Work" by Richard C. Hallgren as a practical example of an interfacing project you can build.

Moving hardware and software advances down to practical applications continues to be one of the most exciting aspects of microcomputing. And as microcomputer power finds its way into more and more of our daily activities, real-world interfacing continues to increase in importance.

—Gene Smarte, Technical Editor

Personal Computer Signal Processing

An introduction to transducers, interfacing, and system development

Bill Englemann and Mark Abraham
Analog Devices

Personal computers are moving into the laboratory and onto the factory floor to act as data-acquisition systems and industrial-process controllers. But many questions need to be answered to fully develop the concept of a low-cost computer system that controls processes many times more valuable than the computer itself.

This article explores the complexities of interfacing personal computers and real-world sensors. We'll look at the kinds of measurements that can be taken, the analyses that can be performed, and the control output that personal computers can generate. We'll examine the role of transducers, analog-to-digital (A/D) converters, parallel and serial communications, bus standards, and software for real-world applications. To fully understand the problems of getting real-world signals into the computer, we'll look at signal conditioning, protection of interfacing circuitry, and isolation of input signals. The accompanying text box, "Signal Processing—Its Uses Today" (on page 96), looks at the kinds of applications being undertaken today by microcomputer-based, real-world systems.

The simplest application of a personal computer in the real world is for data acquisition only (i.e., no outputs). Without a computer, there are two standard approaches to data acquisition—the manual method or using a dedicated data logger. The manual method consists of someone watching some type of meter or display and a clock while writing all of the desired readings on paper. Using a data logger entails hard-wiring the inputs to the box and allowing the system to print out readings at regular intervals or when some predetermined limits have been exceeded. Neither approach lends itself to easy access to the results for numerical analysis. In addition to automating this operation, a personal computer allows you to do better what you really want to do with the data—off-line numerical and graphical analysis (after the data acquisition is complete).

The next level up for a personal computer involves data acquisition with alarming. In this case, the data-acquisition function is performed as before, but an alarm function is added. Alarms typically trigger by comparing the input values to a set of known limit values and driving some output when one of these conditions is met. The output can be any combination of digital outputs, screen messages, and voice outputs to an operator, or data streams to a printer and disk. Digital outputs can be directed to some type of operator alarm-panel display or some type of audible alarm.

On-line data analysis requires more work on the part of the computer. Specifically, in between taking samples it may have to do alarming, acknowledgment of trends, digital filtering, plotting, or storing to disk. Typical on-line analysis has some form of output much like alarming, but does not have the ability to affect the signals coming in.

Real-time control with a personal computer is one level up in complexity. In this type of application, all of the preceding must go on, plus there are additional outputs that directly or indirectly control the functions under consideration. A digital output can directly control a driving device, like a heater can control the temperature. An analog output can "throttle" a variable-output drive like a DC (direct current) motor-driven fan. When DDC (direct digital control) is used, the inputs, algorithm calculations, and outputs are performed by the computer. When supervisory control is used, the computer communicates the desired value (or set point) to "smart" controlling devices and is free from doing the control itself. The actual communication may be via analog output, pulse trains, or communication signal.

Finally, full utilization of a personal computer in an application like this involves using other features of the computer as well. Primarily, the computer can be performing more analysis as well as logging all events and data to disk and printer. One display could include information on each loop, such as the measured value, set point, and control-output status; another display could show the trend of a group of measured values (for example, temperatures) over time; and yet another could show a tabular display of all of the relevant parameters for a particular loop—set point, type of output, control-algorithm parameters, limits, and functional identification. In this mode, the personal computer transforms itself from a replacement for other types of control equipment to an aid in managing the control function as a whole. It provides information and a basis for analysis that has heretofore not been available for this price.

The hardware and software choices made affect how the implementation is done and how well a system works. The operating system chosen should have provisions for real-time operation, efficiency in handling the I/O (input/output) requirements, support of multiple terminals, multitasking, and ideally should be widely used. Real-time operation is important and must be differentiated from time-sharing. While time-sharing operating systems guarantee that eventually all users get as much time as required for their applications, a real-time operating system provides everyone with a regular, guaranteed slice of time.

Choice of programming languages depends on the preferences of the programmer as much as the requirements of the system. There is no language standard in data-acquisition and control applications. Compiled languages virtually are required for real-time operation, yet ease of use for "nonprogrammers" has directed some vendors to supply compiled versions of BASIC with the necessary extensions. The most important thing in choosing a language is to verify that the inputs and outputs are adequately and easily addressed. If at all possible, you should obtain a simple integrated software package. The language you choose must have built-in input and output functions so that you can write software that is application specific, not hardware specific.

A personal computer can not only replace control equipment but can also manage the control function.

Where performance requirements allow, try to purchase an application-software package, but only if you feel confident that you will never have to alter it in a language that doesn't lend itself to what you want to do.

The hardware you choose will be transparent to the application as long as some prerequisites are met. One of your key concerns when buying a personal computer should be dependability, especially if the operator and the programmer are different people. Industrial operators tend to have less respect for computer hardware than programmers do. Unless your performance requirements are minimal, or the external hardware is doing much of the work, you will need a 16-bit microprocessor. A software real-time clock is an asset, but a hardware clock that has battery backup is better. The system must have the capability to automatically load software from disk for unattended operation after a power failure and it must be user-friendly.

Data Acquisition and Control-System Architecture

Once an overall strategy for measuring and/or controlling real-world signals is determined, the architecture of the system must be chosen. The architecture defines the characteristics of how the information is processed: getting it from the real world to the computer and back again. Two common ways to establish communications between a computer and a real-world interface subsystem are parallel and serial interfacing.

A crude way of getting this information in and out of a computer is through an operator interface like a cathode-ray tube (CRT) terminal. An operator could look at a panel of analog meters, record the information on a chart, and later enter the data through the terminal. This method is slow and inaccurate. Errors can occur during the meter reading, the writing of data, or when the operator enters the data. The scan rate is determined by how fast the operator can perform the complete cycle and start over again, and it is extremely slow.

Parallel Communications

Every microprocessor, microcomputer, minicomputer, and mainframe has one or more parallel-bus structures. These buses provide a well-defined means of local communication among the processor, memory, storage devices, and I/O devices. For example, within the IBM PC, the 8088 microprocessor has an internal and an external bus. Also within the PC is the now-familiar IBM PC bus. These buses can have four groups of signals: data, address, control, and power. The sequence, timing, and control of these signals and the form-factor, connector type, and pin spacing are well defined for a given bus.

Once a bus-compatible device is designed and connected, the actual communication with it is controlled by the software of the computer. Three ways to communicate are via memory-mapping, I/O mapping, and DMA (direct memory access).

Memory-Mapped Interface

Certain software commands either

Signal Processing—Its Uses Today

Although some of the greatest advancements in real-world signal processing have been in the area of digital technology, the only things left in the real world that are not analog are fingers and toes. Applying digital technology to what has been traditionally the domain of analog devices brings a new set of problems and challenges.

The term "real world" as it is used in the context of this article refers to electrical signals generated by sensors, transducers, switches, and meters, as well as controllers of electrical or electromechanical devices. Sensors and transducers typically have electrical properties that vary with the physical properties they measure. Sometimes a sensor's output is as simple as a known resistance that varies with temperature, while at other times it outputs an analog signal proportional to the pH of a solution. A real-world signal input can also be a temperature switch that closes at a predetermined level or a series of pulses whose frequency varies with the flow of a fluid through a pipe.

In some cases, electrical phenomenon can be measured directly. In biological research, brain waves can be measured as electric pulses so that both the amplitude and the frequency components of the pulses can be quantified for later analysis. In applications where power is monitored, the amplitude, frequency, and phase of the power source are potential quantities of interest as the load on the power line changes.

Outputs to the real world can be either analog or digital. Digital outputs can be anywhere from transistor-transistor logic (TTL) level (0 to 5 V) to 24 V DC or 280 V AC. Analog outputs can be either current or voltage and may be either simple milliamp signals or power voltages to drive DC motors. Pulse and frequency signals are used to drive stepper motors and gate external events instead of the usual analog or digital outputs.

Why Personal Computers?

When real-world interfacing was primarily analog and even calculations were performed by analog circuits, it seemed that this homogeneous approach was sufficient; but some of these functions are better or more easily performed by digital technology. The advantages of using computer technology go beyond the functions previously possible, particularly in the areas of display, data analysis, and overall system flexibility.

An engine test stand is an example of a real-world interfacing application. The EPA requires manufacturers to test internal-combustion engines. Any changes to an existing engine design, or use of new fuels and lubricants, are tested on an engine in a controlled environment. Without a computer, the test is manually controlled from a control panel where an operator starts and stops the test and performs all data acquisition and on-line calculations. The operator's tools for these tasks are switches and knobs, pocket calculator, pen, and clipboard. Also employed are emissions analysis equipment with output to analog panel meters, a manometer (glass tube with floating air bubble) to determine pressure, and a two-channel X-Y recorder to monitor two analog parameters over a specific period of time. The problems with this method include the inability to accurately recreate the operator's actual control sequence, inability of the controller to react quickly enough, lack of correlation between the control-room data (motors, speed, and pressure) and the analog data on the chart recorder, and no allowance for monitoring more than two analog parameters when there may actually be five or six of interest.

Using a computer-based data-acquisition and control system resolves all of these problems and provides functions never previously considered important. This system guarantees repeatability of control of the test, dynamic decision-making capability, a large database of multiple variables that can be used for more detailed graphical or numerical analysis, and a permanent record both on paper and on disk for audit later.

Personal computers acting as data acquisition and control systems stimulate new levels of analysis. Just as spreadsheet programs motivated people to do more detailed "what-if" analyses, computers applied in data-acquisition and control applications open the doors to more detailed numerical analysis and to different ways of analyzing data graphically.

In some industries, computers have been employed in real-world interfacing applications for some time. These users have become accustomed to high performance levels in real-world signal processing and digital computing. The price of personal computers has remained low as the performance of the machines has increased to the point where they can now replace minicomputers. Many companies are taking advantage of this opportunity by scaling down the software available for the larger systems and providing the same basic functions on microprocessor-based systems.

In turn, this trend of making large-scale performance available in small-scale, inexpensive systems allows the advantages of computer-controlled systems in applications where the cost formerly was prohibitive. In particular, process-control technology that formerly was available only in large process applications now can be effectively employed in a laboratory where the same functions are required. In addition, when a computer is employed, there are other hardware and software packages available that can be used in areas related to the specific application. Word processing programs are used in report writing, statistical analysis programs are used for off-line data analysis, and database programs are used to classify and compare the large quantity of data generated.

There are other benefits to using personal computers. In cases where specialized instrumentation is required, it is either built to specification on a custom basis or you pay for the exact piece of equipment you require. In either case, when the test for which it was designed is no longer required, the equipment is often not usable for any other purpose. Standard computing hardware provides alternative uses for the equipment on some other project or program. In addition, if one computer in particular can be determined to be both flexible and powerful enough for many applications, it will be easier and faster to get up and running.

Using Computer Features

When a personal computer is applied to a real-world interfacing situation, the standard features of a computer become new functions or replacements for old ways of performing the same function.

The inputs and outputs of the computer require an interface to the real world. Personal computers use standard buses to connect to a wide variety of I/O cards. Changing I/O cards enables the system to be used in a different application and, where space is a factor, expansion boxes are available. The flexibility of this kind of system is increased significantly by the fact that the characteristics of the system can be changed by the I/O cards employed.

The communications capabilities of personal computers are a major advantage in real-world interfacing applications. Besides the standard interfacing to external terminals and printers, a real-world interface box often communicates to the computer over one of the many communications standards available: RS-232C, RS-422A, RS-423A, 20-mA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THE BYTE COMPUTER SHOW DELIVERS THE CONFERENCES THAT INFORM.

KEYNOTE

You've been called lots of things, not all of them complimentary! True enough that hundreds and thousands of midnight hours spent bashing one's system around will skew the psyche of most who try it. The result, however, is often a unique perspective—more precisely, a spectrum of perspectives. We are honored to present these "bit-pusher" perspectives at keynote sessions across the country, for an audience of dedicated "bit-pushers" gathered at the various BYTE COMPUTER SHOWS. Your keynoter is guaranteed to be a world-class "bit-pusher", focusing on whatever aspect of The Game is currently of most interest to him/her. Get into your seats early and buckle up for a verbal rocket ride into our shared future!

KN-1 Keynote: Bit-Pusher Perspectives

HARDWARE HELPERS

Keeping up with new developments in microcomputer hardware can be a dizzying task. Knowing what products are available for your system can mean the difference between a machine that is adequate and a computer that is outstanding. The sessions in this group will cover new developments in hardware starting with the latest in 32-bit microprocessors. Next up are sessions covering standards for the industry and chips and boards that you can add to upgrade the performance of your system. The last session in this group gives you the chance to hear other users give their first impressions of the new 1200 bps modems. If you are looking for hardware solutions to your computing problems, this group is the place to start.

HH-1 Who Needs 32 Bits?

HH-2 Is PC Compatibility Holding Us Back?

HH-3 Adding-On For A Supercharged System

HH-4 The 1200 bps Modem: Users Report

SOFTWARE SAVINGS

New developments in computer hardware demand more productive computer software. Two sessions in this group focus on ways in which you can optimize the time and effort you spend on programming. The first session in this group looks at the current state and future direction of legal agreements between software houses and end users. Next, there is a session on the new programming environments which can make the time you spend writing code more productive. The group concludes with tips for helping you decide whether designing your own data-base is the best approach for you, and how to begin if it is.

SS-1 User Agreements: A New Day Dawning?
SS-2 Programming Environments: New Methods and Tools
SS-3 The Home-Brew Data Base: Tips for Home Brewers

LANGUAGE LABORATORY

The availability of new languages for programming microcomputers has given the programmer new flexibility, at a cost of new decisions to be made. BASIC and Assembler are still around, but other powerful languages demand consideration when there is software to be written. In this group, our experts will look at a variety of languages and give their views on the pros and cons of each. In addition to this overview, we take a close look at two popular languages: C, which some experts are claiming will become THE programming language of the 80s, and BASIC, which many have discounted for serious programming, but which may be given new life through one of the new versions recently introduced.

LL-1 Micro Language Forum
LL-2 C Language Tradeoffs
LL-3 BASIC: Can It be Saved?

APPLICATIONS FRONTIER

It comes as no surprise that more and more uses are being found for the ever-increasing power of microcomputers. The sessions in this group focus on some of the topics from the leading edge of new applications. The first two sessions in the group look at applications in the home. Many people first bought computers to help keep track of the family checkbook, but new developments allow the computer to come much closer to "managing" the home as an on-going family enterprise. The idea of a small electronic helper around the house may still sound like science fiction, but our experts will show that a robot of your own may be closer than you think. The third session is special, focusing on new developments in microcomputers which are effecting beneficial change in the lives of the handicapped. The group caps off with a look at the new generation of computers you can take with you, wherever your path may lead.

AF-1 Home/Family Management: Beyond the Recipe Collection
AF-2 Your Personal Robot
AF-3 Systems for the Handicapped
AF-4 When Less is More: Notebook Computers

SOFTWARE HORIZONS

No one is denying that there are many exciting developments in the hardware field, but it would be an obvious mistake to ignore developments in the software arena. Sessions in this important group will cover software developments that will allow you to take fullest advantage of powerful machines just over the horizon. Beginning with the operating systems that will make program development easier than ever before, and ending with the algorithms that seek to make plain ol' English the computer language of choice, this group will take you into the exciting future of advanced software.

SH-1 Next Generation OS: Are Icons Inevitable?
SH-2 Beyond Words: Idea Processing
SH-3 AI Gateways to Natural Languages
SH-4 Voice Pattern Recognition

GRAPHICS GALORE

With the increased power and sophistication of microcomputers, more latitude in the nature of I/O is now available than ever before. First numbers, then words, and now images are being manipulated with relative ease by the new generation of micros. In this group there will be sessions that tell you how to use the extended graphics capabilities of microcomputers to your greatest advantage. The first session focuses on new I/O devices and how to make best use of them. Next, we have a session just for those of you who do not have a system with graphics capabilities, but who have looked with envy at systems with graphics. It may be that there is an add-on system to give you just what you want without the expense of a new computer. Finally, there is a session that looks at the practical uses of advanced graphics, including the exciting new area of microcomputer CAD.

GG-1 Keyboard Alternatives
GG-2 Low Bucks Graphics Add-Ons
GG-3 Micro Graphics Applications

THE BEST IS YET TO COME

There is no industry where changes are coming as thick and fast as they are now in the computer industry. You can take a look over the horizon by attending the sessions in this group. Computer-manipulated video images are already changing commercial television; they are ready now to accomplish the same wonders at home. In the first session, we'll look at computer/video combinations that may forever change the look of home video. Next is a session which takes a long look at what to expect from the major development push underway in Japan. The group concludes with a focus on mass storage devices that will allow dramatic new uses to be made of your largest files and programs in the years to come.

YC-1 Coming Attractions: The Computer/Video Interface
YC-2 Japanese Computer Trends
YC-3 Mass Storage Alternatives

The Conference Coordinators

**Peter B. Young,
Conference Director,
The Interface Group, Needham, MA**
Since 1978, Mr. Young has directed The Interface Group's conference programming and public relations activities for the COMDEX, INTERFACE, FEDERAL DP EXPO, THE BYTE COMPUTER SHOWS and COMPUTER SHOWCASE EXPOs. Prior to joining The Interface Group, Mr. Young established an in-house public relations capability for a leading minicomputer manufacturer in 1971, then held a marketing communications position with a leading satellite carrier.

Curt Franklin, Conference Coordinator, The Interface Group, Needham, MA
Curt Franklin is responsible for planning and implementing THE BYTE COMPUTER SHOWS conferences, The Interface Group's new regional series of computer shows co-sponsored by Byte Magazine. Prior to joining The Interface Group, Mr. Franklin was an instructor at the University of Alabama in Birmingham. His area of specialty was formal language theory.

Philip R. Lemmons, Editor-in-Chief of Byte Magazine
Philip R. Lemmons, recently appointed Editor-in-Chief of Byte Magazine, has had a distinguished career in computer journalism. In 1979, he was editing and re-writing computer-related books. In 1980, he began his association with Byte, becoming the magazine's West Coast Editor in 1982. A National Merit Scholar and Harvard National Scholar, Mr. Lemmons graduated from Harvard College with honors in 1971.

Pam Clark, Editor-in-Chief of Popular Computing Magazine
Pam Clark, recently named Editor-in-Chief of Popular Computing Magazine, joined the Byte editorial staff in 1982 as Technical Editor. In 1983, she became Byte's Managing Editor, then was transferred later Byte's sister publication, ___ Computing. She holds a Master's degree in Instructional Technology from the University of Texas, and managed academic computing services for a network of more than 50 colleges and universities in North Carolina prior to joining Byte Publications.

THE BYTE COMPUTER SHOW/Chicago '84
Conference Program
Schedule by Group

KEYNOTE	DAY	TIME
KN-1 Bit-Pusher Perspectives	5/10	11:00-12:30

HARDWARE HELPERS	DAY	TIME
HH-1 Who Needs 32 Bits?	5/11	11:00-12:30
HH-2 Is PC Compatibility Holding Us Back?	5/11	5:00- 6:30
HH-3 Adding-On For A Supercharged System	5/12	12:00- 1:30
HH-4 The 1200 bps Modem: Users Report	5/12	2:00- 3:30

SOFTWARE SAVINGS	DAY	TIME
SS-1 User Agreements: A New Day Dawning?	5/10	2:00- 3:30
SS-2 Programming Environments: New Tools and Techniques	5/11	5:00- 6:30
SS-3 The Home-Brew Data Base: Tips for Home Brewers	5/12	2:00- 3:30

LANGUAGE LABORATORY	DAY	TIME
LL-1 Micro Language Forum	5/10	5:00- 6:30
LL-2 C Language Tradeoffs	5/11	2:00- 3:30
LL-3 BASIC: Can It be Saved?	5/12	10:00-11:30

APPLICATIONS FRONTIER	DAY	TIME
AF-1 Home/Family Management: Beyond the Recipe Collection	5/10	2:00- 3:30
AF-2 Your Personal Robot	5/11	11:00-12:30
AF-3 Systems for the Handicapped	5/11	2:00- 3:30
AF-4 When Less is More: Notebook Computers	5/12	10:00-11:30

SOFTWARE HORIZONS	DAY	TIME
SH-1 Next Generation OS: Are Icons Inevitable?	5/10	5:00- 6:30
SH-2 Beyond Words: Idea Processing	5/11	11:00-12:30
SH-3 AI Gateways to Natural Languages	5/11	2:00- 3:30
SH-4 Voice Pattern Recognition	5/12	12:00- 1:30

GRAPHICS GALORE	DAY	TIME
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GG-2 Low Bucks Graphics Add-Ons	5/11	5:00- 6:30
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YC-2 Japanese Computer Trends	5/12	12:00- 1:30
YC-3 Mass Storage Alternatives	5/12	2:00- 3:30

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current loop, or IEEE- 488 GPIB (general-purpose interface bus) parallel communications. Distributed systems' architectures are sometimes used with I/O boxes throughout an installation, and all communicate to a personal computer host that does local processing and other necessary functions. Finally, in large installations, the local personal computers communicate to a mainframe host via serial communications, for permanent storage, detailed analysis, and calculations.

Data storage on a computer involves more than programs and data. A floppy disk may hold a number of different configurations for different tests, significantly simplifying the reconfiguring of test conditions. RAM (random-access read/write memory) is important for performing on-line calculations of recent data against predefined limits. Disks and other mass-storage devices also can be used to store long-term data to be used for historical trends or other analysis. Sometimes, particularly in discrete testing applications, storage of parameters for individual test units is maintained for traceability to the test at a later date. Mass-storage devices are also used for temporary storage in applications where raw data is first acquired at high speed, stored on disk, and then retrieved for later calculation and transformation off line, with the results stored as well. In these applications, even the rate of storage on a hard disk can be the limitation on high-speed sampling.

Computer calculations perform functions that previously had to be done with interface hardware (like thermocouple compensation) or by hand (determining short-term averages of signals). Because actual signals in volts are rarely significant alone, some type of conversion to engineering units (degrees of temperature, pounds of pressure, etc.) or simple conversion to percentage values is necessary. Statistical techniques are used to do many things, from simple rolling averages, to eliminating noise, to much more complex analyses of trends, and determining the characteristics of a process. Transformations are made to do frequency analysis like fast Fourier transforms (FFTs) to examine data in the frequency domain or just to invoke digital smoothing techniques. Process-control algorithms can involve large numbers of calculations for each loop controlled, especially when PID (proportional integral derivative) control is employed. These calculations are relatively simple but the speed at which they are performed is often critical.

write data from the processor into a given memory location or read data out of a memory location into a processor register. The memory locations do not have to be true memory devices such as RAM (random-access read/write memory) or ROM (read-only memory), but also can be serial communication devices such as USARTs (universal synchronous/asynchronous receiver/transmitters), numeric data processors, counters, timers, or real-world interface devices.

The memory map of a computer is a tabulation of all the memory locations that a processor can address and the devices that are present at those locations. To communicate with memory-mapped devices the computer needs to know the starting (base) address, the number of locations taken up, the function of each location, the format of data passed back and forth, and the communications timing required for proper operation.

A typical analog-input board designed for bus compatibility might occupy a total of 16 bytes of memory. These memory locations would include a multiplexer channel register used to control which input channel is measured, a command register used to initiate an A/D conversion, a status register that contains the status of the A/D converter, and data registers that contain the value of the analog input in digital format.

Older 8-bit processors could address only 64K bytes of memory, and poking a hole in this memory image for an analog I/O board seriously restricted the use of the space for more important things, like RAM. The IBM PC can address up to 1 megabyte, and therefore it is more willing to give up spaces for devices other than true memory. The sacrifice of memory space is avoided by using an I/O-mapped structure.

Other software commands read or write data to I/O locations (ports). The I/O ports are similar to memory locations, but memory devices typically are not placed in an I/O space. These ports are used for CRT, floppy-disk, or keyboard controllers. Analog I/O devices also can be I/O port-mapped devices. A typical computer may have 256 I/O ports. The 8088 has 65,535 ports.

Bus-Compatible

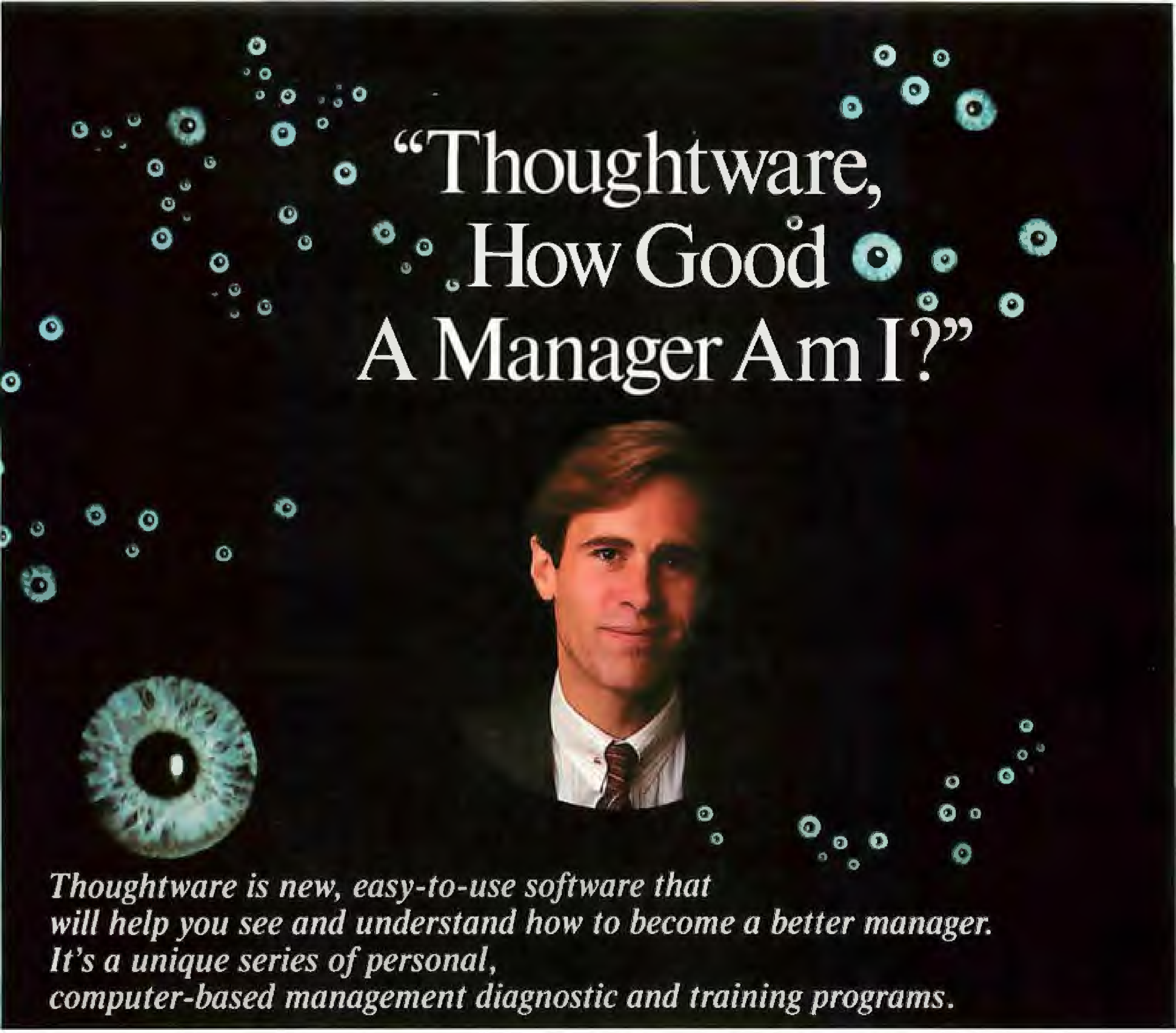
Several analog and digital input and output boards and front-end systems are available for the popular computer bus standards. Some of these buses include the IBM PC bus, IEEE-488 GPIB (general-purpose interface bus), Digital Equipment Corporation's LSI-11 bus, STD Bus, and Multibus.

Use of bus-compatible products ensures a mechanical and electrical compatibility and a well-defined communications method, and also may include software packages that facilitate their purchase. The architecture of these buses is determined by the microprocessors supported and the intended use of the bus. The STD Bus, for example, is widely used with Z80 and 8085 microprocessors in small industrial-control applications.

Traditionally, the LSI-11, STD Bus, and Multibus products dominated industrial and laboratory bus-based computers. During the last two years, however, personal-computer-compatible data-acquisition products have grown tremendously. Systems designed around the STD Bus and Multibus are powerful and flexible but require more money and computer expertise than using a personal computer.

Serial Communications

Just about every computer, whether a home computer connected to a television or a large multiuser business system, has at least one RS-232C port. The huge number of I/O devices using this serial communications standard testify to its ease of use and processor independence. Printers, plotters, terminals, mass-storage devices, bar-code readers, and speech synthesizers are available with RS-232C interfaces, as are real-world interface systems. These include laboratory instrumentation data-acquisition front ends, industrial measurement and control subsystems, and specialized equipment such as high-speed vibration-analysis systems.



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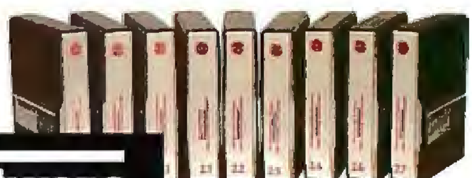

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Serial communications methods afford several advantages over parallel interfacing. A major strong point is the large potential separation between devices. Parallel interfaces operate (if specially designed) up to a maximum distance of 60 feet, compared to several miles with some serial interfaces. This allows a personal computer host to be located in a controlled environment (protected against extremes in temperature, humidity, dust, chemicals, electrical interference, etc.) while an environmentally hardened front end in the industrial area can measure and control a chemical process and communicate all the relevant information back to the host.

Serial interfaces also avoid the intimate relationships of devices that are connected via parallel interface. If the host computer fails, or if you want to do something else besides monitor the process, the front end can operate alone, not depending on the intelligence of the computer.

Real-world interface front ends actually can contain their own computers and be programmed, using any computer or terminal. They are very flexible and easy to use when programmable in a high-level language such as BASIC. These front ends typically don't contain mass storage or display devices, which are better left to the personal computer world. The power of the computer comes into play when storing histories of data from real-world measurements and analyzing, graphing, and printing the data.

Universal Interfaces

In addition to the RS-232C serial-communication standard, there are several other interfaces including the RS-422A, RS-423A, and (informally) 20 mA (milliamperes). Actually, these standards refer only to the electrical levels and types of signals present on the communications link. They do not specify the protocol of the information. The information can be coded using an ASCII (American National Standard Code for Information Interchange), binary, BCD (binary-coded decimal), or hexadecimal format and can be transmitted using a synchronous (including a clock) or asynchronous manner. When a device claims RS-232C compatibility, an ASCII asynchronous protocol is usually implied.

Standards such as HDLC (high-level data-link control), SDLC (synchronous data-link control), and X.25 are synchronous protocols that define not only the electrical interfacing (physical layer) but also the format of data, addresses, control, and error-checking codes that are transmitted.

Distributed Systems

A personal computer used as a host controller with several data-acquisition systems distributed from its serial-communication link (multi-dropped) is a widely used configuration. Each node has stand-alone capability and is located close to the real-world signals, minimizing signal loss, interference, and wiring costs. The host computer collects average and summary information from each node and downloads new set points, alarm limits, or programs to each node.

Large distributed-control systems that include application software ready to run the plant (turnkey systems) can cost several million dollars, include several operator consoles, and measure thousands of points. Today, many control-system engineers use personal computers with distributed data-acquisition front ends and write their own programs to approximate the performance of large turnkey systems on smaller applications. This trend is a result of the cost-effectiveness, power, and programming ease of today's personal computers.

Modem capability is another advantage of using serial communication schemes. Radio and telephone modems allow distribution of real-world interface front ends hundreds or thousands of miles away from the host computer. This approach is used in applications such as natural-gas pipeline monitoring, electric utility substation data acquisition, and data collection from oil fields.

One disadvantage of serial communication is its limited throughput of data. Many applications simply cannot be measured or controlled unless a high-speed parallel interface is used, although this limitation is being overcome by putting more intelligence in the front end, thereby reducing the amount of data that must be transmitted.

Design Considerations

The cost of implementing an application solution based on a real-world interface board or system with a personal computer includes the cost of the device itself, its hardware and software packages, the cost of configuring, wiring, or connecting the devices, and the cost of making them perform through user-written software.

The time and effort of this process is inversely proportional to the completeness of the purchased solution. A turnkey system is designed, programmed, tested, installed, and operational before a user ever touches it. You also pay much more for this system. At the other extreme, a minimum solution requires that you make a large commitment to hardware and software design. The attractiveness of this approach depends on the experience and time the user has and also on the level of support the vendor can supply.

Software

The class of analog I/O products designed to interface through a computer's parallel bus appears to the system software as a block of memory locations or I/O ports. Application software that can be included with these products can sample analog inputs, graph the information on the monitor, store historical data to disk, and do various data manipulations. This software is useful during the initial setup of the system, but may not be adequate for the actual application. Here's the catch: how do you find the memory locations the board is mapped into and how do you format the data, control the board, and control the timing? Unfortunately, typical users of these products are not assembly-language programmers, they're laboratory personnel who have many different specific tests to run. Fortunately, the vendors of these analog I/O-board products generally recognize this and provide software "hooks" to access the board. Consisting of subroutines that can be called from high-level languages, they do not restrict you to just one language: they often can be used with BASIC, Pascal, and FORTRAN. Sophisticated users can bypass the formality of these subroutines and use just PEEKs and POKEs or write their own assembly-language routines.

Real-world interface systems that communicate over a serial link (front end) range from those that are completely programmable in a high-level language to those that understand only a few cryptic command codes. The software packages may include communications routines to be used in the application program or for developing programs on the front end. The most flexible products allow programs to be developed and downloaded from the other tasks while the stand-alone front end is measuring inputs, controlling outputs, etc.

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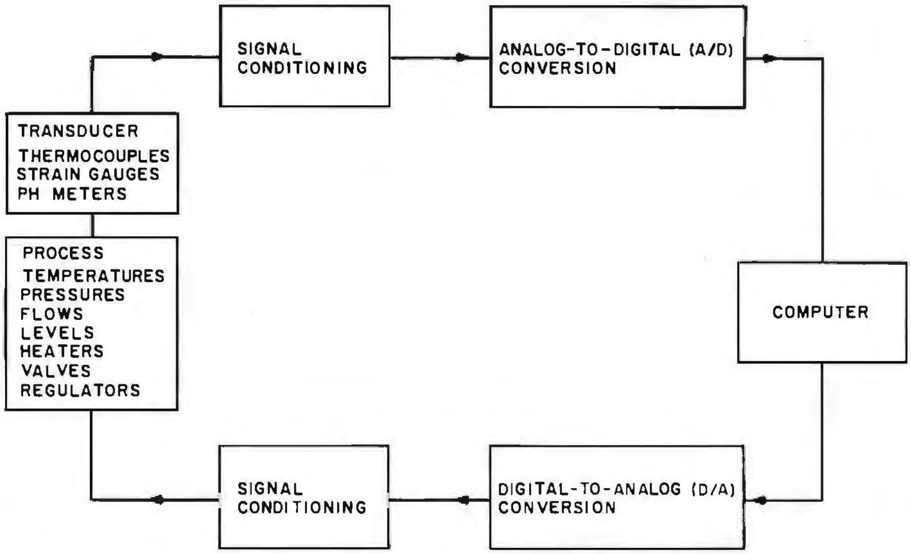

Figure 1: *A example of a measurement and control loop.*

Potential users of any type of real-world interface device should learn exactly how the application software is developed, what languages are used, what application-related software is included, and whether the front-end unit can stand alone or needs the host computer to supervise its activities.

Potential users also should question what types of real-world signals can be measured and how they are connected to the device. Systems that look great in ads and perform flawlessly in the demonstration often turn out to be a nightmare to implement. This happens because there are two different components connected: your computer and someone else's I/O board or front end. No one can predict all the computer's variables, such as memory size, operating-system revision, other manufacturers' boards used, type of monitor connected, or whether it is really compatible to that well-known brand of PC.

Interfacing with Analog Signals

Internally, a computer understands binary digital information. It is the job of the real-world interface instruments and systems to change real-world physical phenomena into this digital format.

As figure 1 shows, various physical phenomena such as temperature, humidity, pressure, level, and displacement can be converted to analog voltages by transducers and appropriate signal conditioning. The function of signal conditioning is to translate the transducer output into a suitable standard form for the A/D converter, while filtering the signal and protecting the converter from high common-mode voltages and voltage transients. Similar functions are performed when a computer wants to output signals that control real-world phenomena.

The sensors and transducers actually are connected to the real world, converting physical phenomena into representations that can be changed into an analog voltage. Sensors may output a voltage directly or may produce or vary resistance, capacitance, or inductance.

Temperature

Mercury thermometers and bimetallic strips convert temperature into a visual form that humans can measure directly, but they are not suitable for conversion of temperature into voltage. Instead, thermocouples, thermistors, RTDs (resistance temperature detectors), and other devices are used.

Thermocouples are based on the physical principle that whenever two dissimilar metals come in contact, a voltage roughly proportional to temperature is formed across the junction. Various combinations of metals are used, depending on the overall temperature range to be measured. An iron-constantan thermocouple, ANSI (American National Standards Institute) type J, has a 0-to-58-mV (millivolt) output for a temperature range of 0 to 1000 degrees Celsius. You may note that, to measure this output, electrical connections must be made to the thermocouple, forming two additional dissimilar-metal junctions. The errors that result are minimized by a circuit in the signal conditioner called cold-junction compensation. The output of a thermocouple is a highly nonlinear function of temperature. Software routines are often used to linearize this relationship and may use a fifth-order polynomial to do so.

Thermistors are semiconductor devices with a large, negative temperature coefficient of resistivity. The resistance is measured and converted back to temperature. Temperature also is measured by other semiconductor devices such as the AD590. This device is a current regulator that passes 1 μA (microampere) per degree Kelvin. At room temperature (27 degrees Celsius), 300 μA flows through it. In this case, the signal conditioning provides excitation and converts the low-level current into a voltage representation. RTDs are made of conductors, such as platinum and nickel-iron, whose resistances change with temperature. Signal conditioning provides a regulated current excitation, and the voltage that results is measured. The relationship between resistance and temperature is slightly nonlinear and must be corrected by a hardware- or software-linearization scheme.

Other Phenomena

Strain gauges are used to measure pressure, force, acceleration, displacement, and weight. They are small, thin resistors that are placed in direct contact with the object to be measured. As the object moves, the strain gauge also moves, stretching, compressing, or otherwise distorting the resistor and changing its value. Wheatstone bridges are typically used for excitation and conversion of the output to voltage. Pressure transducers and load cells are complete mechanical packages that contain the

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Devices used for controlling real-world phenomena include heaters, valves, pressure regulators, and actuators. This instrumentation typically accepts a standard 4-to-20-mA process current from the controlling system.

Signal Conditioning

The term "signal conditioning" broadly refers to all the functions required to interface with real-world instrumentation and provide the proper voltage levels for the A/D converters, while processing the signals to maintain accuracy and protecting the equipment and operators from the dangers lurking in the real world. These functions include: amplification or attenuation, input and output protection, transducer excitation, filtering, isolation, cold-junction compensation (thermocouples), and voltage-to-current conversion.

Devices on the market known as signal conditioners may contain some or all of these functions and provide the interface from real-world instrumentation to A/D and D/A (digital-to-analog) converters. These converters operate with standard high-level analog voltage ranges such as −10 V (volts) to +10 V, or 0 V to +5 V. It is necessary to amplify low-level analog signals such as thermocouple outputs to high-level voltages. High-grade instrumentation amplifiers are used for this because of their temperature stability, accuracy, and high common-mode rejection. D/A outputs frequently are converted to 4-to-20-mA signals for transmission over long distances (many miles) without signal loss and for process-control instrumentation compatibility.

Protection

Many industrial applications absolutely require protection on all I/O connections against accidental connection to AC (alternating current) mains. This can happen when an operator makes a wiring error, when cables or terminal strips are mis-

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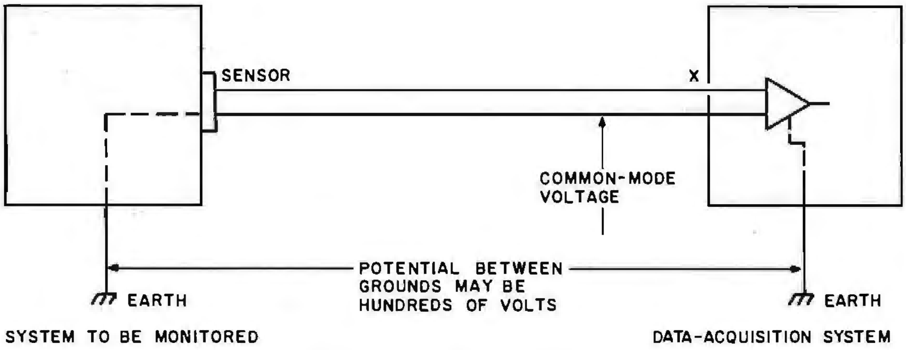

Figure 2: *Very high common-mode voltages can appear on signal lines if isolation techniques are not employed.*

Characteristic	Magnetic Linear Modules	Optical	Flying Capacitor
Common-mode resistance ratings	Excellent	Excellent	Excellent (layout critical)
Common-mode voltage ratings	Excellent	Excellent	Fair
Bandwidth	Good	Good	Poor
Application difficulty	Easiest to apply	Requires isolated power	Extremely poor
Power-supply requirements	Usually single supply	Usually bipolar	Coil drive required
Multichannel applications	Yes	Yes	Yes
Isolated front-end power	Developed internally	Must be provided	Not required
Long-term stability	Excellent	Fair	High maintenance (relay failure)
Stability over temperature	Good	Good	Excellent (with expensive relays)
Leakage current	Excellent	Excellent	Good (at low common-mode voltages)
Input protection	Provided	Provided	Yes (with difficulty)

Table 1: *A comparison of isolation techniques.*

labeled, or during an electrical malfunction. If a motor winding short-circuits to the housing, all connected instrumentation could be carrying large voltages to the analog interface system. If the system is not protected, it and possibly the computer can go up in smoke. Protection up to 240 V AC is common in today's industrial-grade signal-conditioning components and systems.

Excitation

As mentioned earlier, many transducers do not produce a voltage output directly; they require some sort of voltage or current excitation. RTDs can be supplied with a current (0.2 mA, typically) or can be placed in a Wheatstone bridge that is excited by a voltage (10 V, typically). Resistance devices whose changes in resistance are measured rather than their absolute values, also are measured in bridges.

Filtering

Signal lines from transducers often contain extraneous signals that are not representative of the physical phenomena being measured. This is termed loosely as noise. Most noise associated with analog signals is of the 60-Hz (hertz) variety, which abounds in industrial environments. Noise can be reduced by analog filtering of the signal lines or by digital filtering accomplished in the computer's program. Integrating-type A/D schemes also reduce noise by averaging the signal over a period of time.

Isolation

Isolation provides an input-to-output path for the signal to travel without a direct galvanic connection. This may sound magical, but it is needed when dangerous ground loops or large common-mode voltages are present (see figure 2). While the sensor output is low-level (perhaps mV), the common-mode voltage may be hundreds of volts.

Consider a battery-charging application. Hundreds of low-voltage batteries are placed in series and a large-voltage (possibly 500 V) battery is placed across the series string. Each battery has a differential voltage of 2 or 3 volts, but the common-mode voltage is 500 V on the last one in the series. If this last battery were connected to an analog-input system without isolation, a small fire could result. This is an extreme example, but many applications have 120 V AC floating around on all the signal lines (measured with respect to the computer's ground.)

Isolation is performed in basically three ways: magnetic linear modules (transformer), optical, and flying capacitor (see table 1). Magnetic isolation is accomplished by modulating a low-level AC signal by the incoming analog voltage, passing it through a transformer, and demodulating it on the output. Input-to-output isolation of several thousand volts is common using this technique.

Optical isolation depends on passing the signal information from an LED (light-emitting diode) to a light-sensitive transistor (opto-isolator). Isolation of several thousand volts also is available using this technique.

Flying-capacitor isolation is a technique in which a capacitor is alternately switched between the input, charging it up to the input voltage, and the output, which is measuring the charge. Traditionally, relays have been used to do the switching, and because this is a mechanical technique, the lifetime of these devices is not very long. Flying-capacitor isolation is a low-cost technique but is becoming outdated.

The cost for good-quality signal conditioning is small compared to the insurance it provides against elec-

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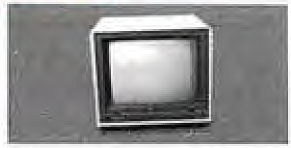

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trical damage and erroneous data, and because of the operator protection it offers. Signal conditioning may be contained within a data-acquisition system or may be performed by a separate subsystem. Two-wire transmitters are single-channel signal conditioners that are mounted at the sensor and produce a 4-to-20-mA output for long-distance transmission to a central control room.

A/D Conversion

The interface between the analog and digital worlds happens inside an A/D converter. It must convert a high-level (−10 V to +10 V) analog input into a digital representation with 10, 12, 14, or even 16 bits of resolution. The digital output can connect directly to a microprocessor's data bus and appear as a memory or I/O device. The processor must tell the A/D converter when to start a conversion and must monitor its status to determine when the conversion process is completed. High-speed "flash" converters convert in less than 1 μs (microsecond), while integrating A/D converters may take up to 100 ms (milliseconds). Two popular types of A/D converters are used in personal computer data-acquisition systems.

Successive Approximation

This type of converter measures a constant analog-input voltage and requires a period of between 1 to 25 μs while it "successively approximates" the digital bits until an internally generated D/A converter output equals the analog input. The analog input must be held constant during the conversion period by a sample-and-hold amplifier. This type of A/D conversion is used for high sampling rates and where noise rejection is not a major concern.

Integrating

This type of converter is used where noise, especially 60 Hz, is a problem and high sampling rates are not needed (less than 1000 readings/second). This A/D conversion integrates the analog input over a period of time, usually 16.66 ms or some other submultiple of the 60-Hz period. The result is an average value filtered of AC components.

A stable and accurate analog reference point voltage (usually +10.00 V) must be supplied to A/D converters. Circuits containing A/D converters are layout-critical, and inexperienced analog designers usually go through a period of trial and error before a design is finalized.

D/A Conversion

D/A converters are simpler devices than A/D converters and they work by summing current into an output node from a series of internal switches controlled by the digital inputs. The output current is usually converted to a signal in the range of −10 V to +10 V. The processor places a digital value at the input of the D/A converter and the output assumes the corresponding analog value within a specified "settling" time.

End users rarely design converter boards unless the volume is large or the application is unusual. Usually, there are too many cost-effective solu-

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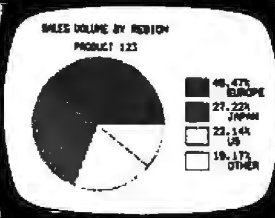

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tions already available to justify designing in house.

Interfacing with Digital Signals

It may seem that interfacing a computer with real-world digital signals does not require special consideration. They already speak the same language and, in many cases, the interface is simple. However, the real world possesses many anomalies not found in a computer bus.

Digital input signals are found coming from operator push buttons, limit and proximity switches, and flow and power meters. Digital outputs are used to perform on-off and time-proportional control of stepper motors and other devices such as valves and solenoids.

The major consideration when interfacing to real-world digital signals is to use isolation. Isolation can be accomplished by relays or by optical methods, and many digital I/O subsystems are available for this purpose. Industrial I/O front ends and subsystems include isolated-frequency measurement, pulse counting, and pulse-train and contact-closure output.

Conclusions

To industrial real-world interfacing applications, the revolution in personal computers has meant that the cost of adequate computing resources has been drastically reduced. In addition, the open nature of computer hardware and software is conducive to offering an end user many levels of "packaged solutions" to attack the real-world interfacing problem. Further development of standards in the industry will nurture more standard products, both hardware and software, that will make solutions easier and more cost-effective to implement.

To really penetrate these application areas, barriers other than price will become of greater importance as time goes on. One of these is ruggedness—a personal computer's ability to be used in industrial environments. In distributed architectures the computer can be located in a controlled environment while the front-end boxes reside in harsher environments. Ultimately, in these applications more intelligence will be required closer to the process or I/O, and, in small-scale operations when it won't be feasible to separate the two pieces, "hardened" computers will be required. Otherwise, the cost of industrial packaging will eclipse the cost of computing hardware.

The mechanical pieces of the computer must be improved—namely the keyboard, CRT, and disks. A standard QWERTY keyboard is intimidating to an industrial operator, and current key-switch technology is not practical for dirty or corrosive industrial applications. CRTs in industrial environments must be able to withstand great temperature variations, must be in a sealed package, and must be 19-inch rack-mountable. The use of removable sealed mass-storage media and backup will become more important; current floppy disks are the worst possible media for harsh environments. Bubble memory is certainly a possibility for this application when the cost becomes competitive. There are some vendors now with hardened peripherals that are intended for use in these applications, but cost limits their use (a touch-sensitive CRT for industrial environments can cost as much as the computer it connects to).

As is always the case in this field, technology advances coupled with price/performance improvements always can find new applications. The trend of applying personal computer technology to real-world interfacing industrial applications already has begun and will permeate the industry for years to come. Real-world interfacing is more than just connecting an A/D converter to a computer. The widespread use of computers will force vendors to come up with more complete and cost-effective means for providing this function. ■

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Mark Abraham holds a BSEE from Rutgers University and is a senior systems applications engineer for Analog Devices' Measurement and Control Division.


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30 kHz Sampling	**Yes(6)**	**No**	**Yes(7)**	**Yes**	**No**
High Speed Programable Ranges	Yes	No	No	Yes	No
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16 Digital Outputs	**Yes**	**Yes**	**+ $175(11)**	**+ $350**	**+ $710**
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Programable Timers	Yes	Yes	Yes	Yes	+ $555
Realtime Clock	**Yes**	**Yes**	**No**	**Yes**	**Yes**
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Foreground/Background	**Yes**	**No**	**Yes(14)**	**Yes(14)**	**No**
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A JOINT VENTURE IN WORKSTATION DATA ACQUISITION

Planning a Computerized Measurement System

An introduction to digital processing of analog signals

Craig R. Wyss
University of Washington

Instead of peering at a wandering meter dial or at a squiggly line on a strip chart, why not let a computer get the eyestrain? Better yet, why not let the computer process that information as well as collect it?

The key to getting the most out of computerized measurement is careful planning. You need to: decide how often to sample the data signal and with what resolution, choose what computations will be performed by the computer and which ones by custom analog or digital circuitry, and decide what information to process in real time (while the measurements are being made) and what information to save for later processing.

Sampling Data

A measurement system must usually deal with a signal that is the voltage analog of some physical variable. To perfectly record such a signal, you would need to note its exact value at every moment. This isn't practical, so the task is to take samples of the signal with enough frequency and accuracy that you can store a reasonably close facsimile of the signal. However, how frequent is frequent enough?

The Nyquist sampling theorem says that the sampling rate (the number of data samples taken per second) should be at least twice the frequency of the sampled waveform. Consider, for example, a periodic signal with a fundamental frequency of about 3 Hz (e.g., the arterial blood-pressure waveform of someone exercising). If you were to accept a reconstruction consisting of the fundamental and up to the fifth harmonic (18 Hz), then you would need to sample the signal at least 36 times per second. As another example, consider a digital audio system. It would have to reconstruct signals of up to 20 kHz, so it would need to have a sampling rate of 40,000 per second.

Even a high sampling rate is not a guarantee of accurate signal reproduction. Accuracy also depends on the resolution of the A/D (analog-to-digital) conversion. In other words, if you have an A/D converter that cannot detect voltage differences of less than one-half volt, then you should not expect great accuracy when you feed it a signal that varies from 0 to 0.75 volt. A 12-bit A/D converter limits your ability to reconstruct a signal to 1 part in 4096 of the full range of the converter. Thus, if the 12-bit converter has an input range of −10 to 10 volts (so that it has a resolution of about 4.9 millivolts) and your signal varies from 0 to 0.5 volt, your maximum accuracy is about 1 percent.

The choice of sampling rates is one of the really critical parts of planning a computerized measurement system because the choice sets the limits on the amount of signal processing that any particular computer can do. Doubling the sampling rate extracts two penalties: it doubles the overhead associated with servicing the A/D coverter, saving raw data, and so on; and it can more than double the processing time associated with making computations on the data. Thus, you should always choose the lowest sampling rates that will allow acceptable resolution of the features of interest in signals.

Note that errors occur when your system monitors signals that have frequency components above twice the sampling frequency. Aliasing occurs when the sampling rate is slightly different than some multiple of a high frequency component of the signal. When that happens, a spurious low-frequency signal appears to be present. Even if aliasing does not occur, frequencies in the signal above the sampling bandwidth appear as noise in the sampled data. The solution to these problems is not to increase the sampling rate, but rather to decrease the signal's bandwidth before it is sampled. I will discuss next how this and more may be accomplished.

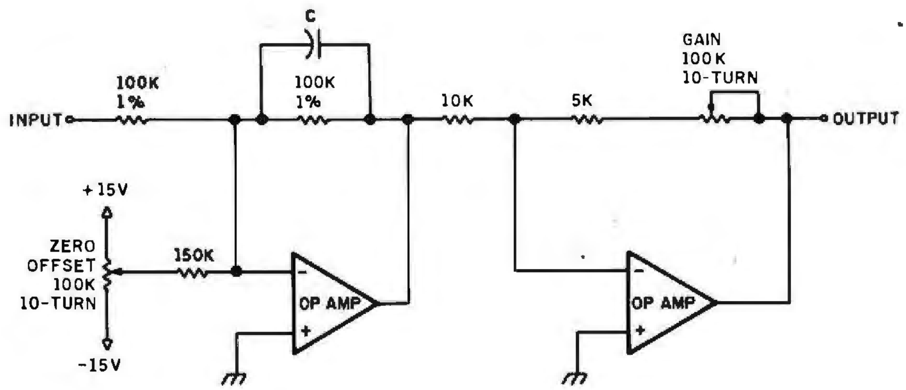

Figure 1: *An analog signal-conditioning circuit.*

Analog Preprocessing

Useful signal-processing systems existed before the advent of electronic digital computers. Millions of hours of effort have been directed at designing analog circuits that perform computations on the analog representation of measured variables; analog computers built from such circuits are still used for some types of modeling tasks.

Virtually all measurement systems do some analog processing. For example, the conversion of a physical variable into an electrical signal is an inherently analog process; this transformation is usually accomplished by a special-purpose device—a transducer—and associated electronics. The transducer and its electronics are often purchased as a package over which a user has little control. Consequently, most such packages do not produce the optimal signals for digestion by the computer in any particular setting.

The signal from the transducer electronics is unlikely to be the best size for your A/D converter, or you might be interested in only a restricted part of its full-scale range. Very often the transducer bandwidth will be too high for the appropriate sampling rate, or high-frequency noise will have crept into the signal. Thus, every A/D converter in a general-purpose measurement system should have some means of adjusting the range, offset, and bandwidth of signals. Figure 1 illustrates a simple analog circuit that performs these services for noncritical applications.

The operational amplifiers that you use in this circuit are not critical for the component values shown. The first stage of the circuit has a gain of negative one and provides input zero offsets from −10 to +10 volts. This stage also acts to limit high frequencies via the first-order, low-pass filter created by the capacitor, C, in the feedback loop; a value for C (in microfarads) of 3.2 times the sampling interval (in seconds) will result in 3-dB (about 30 percent) signal attenuation at one-half the sampling rate and 6-dB (one-half) per octave roll-off at higher frequencies. The second stage provides adjustable gain from 0.5 to 10; if zero offset is adjusted first, the gain and zero will not interact. Since each stage inverts the signal, the output has the same polarity as the input. Input impedance is 100 kilohms. For circuit-error analysis or more sophisticated designs, see references 3 and 4.

Analog processing can reduce the required sampling rate or relieve the computer's processing load. As an example where analog processing might be useful, consider a situation in which you need to know the peak pressure generated by an explosion. The required sampling rate might be more than 10 million samples per second and thus beyond the capacity of all but extremely expensive, special-purpose processors. An analog circuit called a peak detector would allow even a slow computer to sample the peak value at its leisure.

Analog processing can also improve accuracy in some cases. Suppose you are interested in the difference between two signals of almost equal magnitude. Using a computer to do the subtraction could leave only a few bits of accuracy left in the difference, and you have doubled the computer's work load by making it sample two signals instead of one. An analog differential amplifier would perform the subtraction and preserve computer processing time and accuracy.

Hundreds of analog circuits have been designed to do all sorts of useful processing, and for very fast computations they are usually the method of choice. As a general rule, where an analog circuit is available to perform some calculation, it will do it faster, but less accurately and less flexibly, than a computer. References 1 and 2 will get you started with analog-circuit design, and references 3 and 4 give a number of circuit designs for analog processing.

One other class of signal preprocessing—event counting and timing—needs to be discussed. Using a computer for event counting and/or timing is like using a howitzer to kill flies. There are inexpensive digital circuits designed expressly for the purpose of counting and timing events and then feeding the results to a general-purpose computer. Many A/D converter cards for popular microcomputers contain at least one such circuit, and expansion cards designed to count and/or time multiple events are also available. It is generally appropriate to use a computer for event logging only when you have computer power to burn or when an unusual amount of signal processing needs to be done to determine what constitutes an event. In most situations, the simple 1-bit A/D circuit called a comparator (i.e., a level detector) will suffice for identifying events.

Digital Signal Processing

The big advantages of digital over analog processing are accuracy and stability. Once a data value is present in a digital system it can be maintained or manipulated with no loss of accuracy. It is extremely difficult to design analog circuits that can preserve even 0.1 percent accuracy; noise, drift, and nonideal device properties are a constant challenge.

Computations that require the accumulation of information over long time periods are especially difficult to implement with analog circuits because electronic storage elements (capacitors) are limited in size and number for practical designs. Digital processing is almost always the way to go when data needs to be held for more than about 30 seconds. I once needed to generate a very slow (20 minute) voltage ramp for controlling an experiment; the analog circuit to do this is theoretically trivial, but the practical solution was not. It was easier to use a digital counter to produce a numerical ramp combined with a digital-to-analog converter to get the voltage.

Because digital circuits are so good at holding data, signal processing tasks are now possible that were impractical when only analog delay-lines or tape loops were available for storing data. These tasks are those that require looking back in time. Thus, a digital processor can conveniently make computations with respect to an event based on signal values sampled substantially before the event.

An example of digital processing that illustrates most of its strengths is the computation of average transients. In many real-world situations, the desired signal is buried in noise that cannot be eliminated by analog filtering (if the signal and noise have similar frequency spectra, there is no general way to filter out the noise without filtering out the signal as well). The average transients technique comes to the rescue when there are multiple chances to observe the same signal. By averaging many observations of the signal plus noise, the signal gets reinforced while the noise is averaged out toward zero; the signal-to-noise ratio is improved in proportion to the square root of the number of observations. A neurophysiologist might use such a system to help determine which neural pathways lead to the blink of an eye, and oil company geologists use them to separate experimentally generated seismic signals from background noise.

Using a programmable computer to do digital processing confers two vast advantages over custom-designed digital circuitry—flexibility and ease of development. These advantages save so much time and money that only defense contractors are likely to be found designing custom digital circuitry when a programmable computer could do the job.

It is extremely difficult to design analog circuits that can preserve even 0.1 percent accuracy.

In the rest of this article I will assume that you are using a general-purpose mini- or microcomputer for signal processing. However, you should be aware that microprocessors designed specifically for real-time signal processing have been available for the past few years. These processors usually have on-chip 8-bit analog-to-digital and digital-to-analog converters, hardware multipliers, and very short cycle times. The processor designs are generally optimized for digital filtering (see reference 5), but they might also be used as an alternative to analog processing in numerous other applications where signals have frequency components up to about 100 kHz.

Real-Time versus Batch Signal Processing

Let us assume that you have decided what needs to be measured, applied appropriate analog and/or digital preprocessing, arranged for data sampling at close to the optimal (i.e., lowest) rate, and have some data processing in mind for the computer to do. At this point you need to decide what calculations to do as the data is being collected (in real time) and what needs to be saved for later processing in off-line or batch mode.

Any result used for feedback during a measurement session clearly needs to be calculated in real time. These results might be used in experimental control or perhaps to provide a visual display as the data is being collected. At the other extreme are the situations where you haven't decided just what sort of analysis you will want to apply to the data or where the hardware or software necessary for an analysis is not available. In these cases, data must be saved for later analysis. When the choice between real-time and batch data processing is not clear, the following points should be considered.

The advantages of batch processing of measured data are twofold. First, you do not need to decide before every measurement just what analysis will be done. In most cases, data processing that occurs in real time (whether done by analog circuits, digital circuits, or a computer) reduces the information content in the signal and thus precludes some types of later analysis. Saving raw data for batch processing can therefore allow much greater flexibility and can possibly save having to rewrite a real-time data collection program every time a new type of data analysis is desired. The second major advantage of batch data processing is the ability to perform computations that require more time than is available in real time. Complex digital filtering, statistical or correlation analysis, and most types of mathematical transforms, for example, all require more processing time than is available in many measurement situations.

The advantages of real-time data processing are also twofold. First, the amount of data that needs to be printed or saved on mass-storage devices is usually greatly reduced, since only results need to be saved rather than all of the data that had to be sampled to resolve the features to be analyzed. If your required sam-

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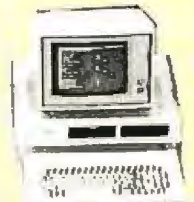

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pling rate exceeds your capacity to save data, this consideration will mandate at least some real-time data processing.

The second advantage of real-time data analysis is that it relieves you from having to do it later. This may seem obvious and unimportant, but it can have a major impact on overall computer usage. In one application, I was able to reduce the batch-processing time for a 3-hour experiment from 6 hours to a few minutes by saving only data that had been partially preprocessed in real time. (The apparent magic involved in doing 6 hours worth of processing in 3 hours of real time resulted from the fact that the real-time program had to be efficient, while the batch program didn't have to be and wasn't.) As a rule of thumb, I normally consider any measurement situation with more than 100,000 data values per hour to be a good candidate for some real-time processing to reduce the burden of data storage and subsequent batch processing.

How do you determine if a particular analysis task can be done in real time? Time constraints will determine the answer, and I have a few simple rules to help you make an estimate. The first step is to estimate the minimum sample cycle time. This is the time required to collect a sample, save it somewhere, and do all associated housekeeping. This time depends on both hardware and software; it might be as low as 10 microseconds for a fast analog-to-digital converter being controlled by a well-written assembly-language program, or it might be 10 milliseconds for a simple converter being controlled from an interpreted BASIC program. This time sets an absolute upper limit on the total sampling rates of all sampled channels and, thus, on effective measurement bandwidths.

Next, you have to estimate the average processing time you need to execute your data-analysis algorithm. It is often easiest to do this by writing a test program that applies the algorithm to a known quantity of dummy data. The average sample cycle time can then be computed as the sum of the minimum cycle time and the average algorithm-processing time needed for each sample. This time sets the absolute limit on the data sampling rates that can be maintained while still performing the desired analysis.

Finally, examine your algorithm and all real-time tasks that you plan to do to find the most time-consuming set of conditions that could be encountered; we'll call this the maximum sample cycle time. This time will normally be much longer than the average sample cycle time since occasional tasks, such as updating a screen display or dividing sums to get averages, can consume many machine cycles.

If you write only the most straightforward data-collection program, your sampling rates will be limited by the maximum sample cycle time. In this simplest programming approach, each sample is collected and analyzed before getting the next sample. Thus, you need to leave enough time between samples to do

your most time-consuming jobs or you will lose data. An alternate but trickier programming approach lets the sampling interval approach the average sample cycle time by collecting and saving samples asynchronously with respect to other processing tasks. For more information about efficient real-time programming techniques, see references 6 and 7.

A Real-World Example

To illustrate and summarize the principles outlined in this article, I will briefly describe BEAT, a real-time program I wrote to monitor experiments in cardiovascular physiology. The overriding characteristic of cardiac signals is that many of the most interesting things happen very fast (as the heart contracts) but not very often (once per cardiac cycle). BEAT was designed to capture this information from each heartbeat.

I measured blood flow and pressure in the ascending aorta (the big artery leaving the heart) using specialized transducers with associated electronics. Analog circuits scaled and filtered the signals as needed by the 12-bit A/D converter and the sampling rates. The 12-bit accuracy of the converter was more than sufficient, since the transduction and analog processing left the signals with an accuracy of only 1 percent.

Ascending aortic flow is nonzero for a relatively brief part of the cardiac cycle (for about the 150 milliseconds when the left ventricle is contracting and the aortic valve is open). Since the peak flow is stable to within 1 percent for only about 4 milliseconds, I chose a sampling rate of 250 per second for this channel (a bandwidth from DC to 125 Hz). Due to the dynamic characteristics of the arterial tree, aortic blood pressure changes much more slowly than aortic flow; a bandwidth of only 30 Hz allowed reconstruction of the pressure waveform to well within 1 percent accuracy. Thus, the arterial pressure channel was sampled at one-fourth the rate of aortic flow samples. The raw sample rates for these two variables plus others I measured were about 1000 per second. The raw data from a typical 5-hour experiment would

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have required about 36 megabytes of mass storage. It was a clear candidate for real-time processing.

I needed to calculate: the cardiac cycle length, the integral of aortic flow minus its value just prior to a heartbeat (the stroke volume), the average pressure, the systolic and diastolic pressures, the maximum rate of change of pressure, and similar sorts of information about other measured variables. BEAT extracted this information from the raw data samples for each heartbeat and then saved the computed values on a mass-storage device.

The analog and custom digital circuits I would have needed to duplicate my computerized system would have been complex, inflexible, and difficult to calibrate. For instance, the stroke volume computation required looking back after detecting a heartbeat to the period when aortic flow was known to be zero. Current flow transducers suffer from slow zero drift, so an analog circuit to compute stroke volume would have been an endless source of frustration. Reference 8 outlines the problem in more detail and explains some other tricks we can do with the computer and aortic flow.

The processing time necessary to sample data, keep running sums, compute extrema, and so on, required about one-fourth of the available machine cycles. However, at the end of each cardiac cycle, BEAT had to perform tasks that required about 150 milliseconds. These tasks included preparing the extracted data for writing to mass storage and passing the data along to the device controller, computing a number of derived variables (heart rate, the current time, average pressure, etc.), converting the derived variables to engineering units and displaying them on a video monitor, echoing the derived values as analog voltages via a set of digital-to-analog converters, testing the keyboard for any special instructions from the user, and initializing in preparation for processing the next beat.

The time required for end-of-beat processing presented a programming dilemma. I might have ignored 150 milliseconds of the measured variables after the end of each beat (thereby missing the most important part of the cardiac cycle), or I might have forgone some or all of the end-of-beat processing. Both of these unpalatable alternatives were avoided, however, because even at the highest observed heart rates, only about 85 percent of the computer's time was needed to do all sample and end-of-beat processing. The problem was to somehow keep sampling data at the proper times even when the computer was busy with the time-consuming end-of-beat tasks.

The job of independent data sampling was relatively easy for BEAT because the A/D converter was a smart device that could be programmed to collect samples and save values in its own memory. Analog-to-digital converter systems with this sort of independent processing capability are becoming commonly available; for example, Data Translation makes them for the IBM PC that sell for $1200 and up. In the more usual case where a smart analog-to-digital converter is not available, the same independent effect can be achieved with a simple service routine that is called via hardware interrupts generated by a clock. The usual time cost for such servicing might be 50 to 100 microseconds for one channel plus 10 to 30 microseconds for each extra channel sampled.

The BEAT program was largely written in a relatively inefficient compiled version of BASIC; only one small routine to maintain the sample buffers needed to be written in assembly language. This illustrates the point that you don't need to be an expert assembly-language programmer to write useful measurement-monitoring programs. Once you have written (or gotten someone else to write) the possibly tricky routines to sample signals and maintain a well-organized buffer of sampled values, then, with only reasonable care and programming skills, you can turn your computer into a flexible data-collection and signal-processing tool.■

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Designing Systems for Real-Time Applications

Some pointers to keep in mind before you tackle a real-time design

James Isaak
Charles River Data Systems

A real-time system is one that responds immediately to your commands and processes data as soon as the data is produced. The opposite of a real-time system is a batch system, which batches commands together and processes them en masse, with no concern for immediate response.

Most personal computer users are familiar with applications that require some real-time operations. For instance, simple text editing or word processing must provide timely response to keystrokes and commands to prevent user frustration. Games require even more demanding real-time characteristics.

Applications that involve audio-frequency monitoring are quite demanding. To accurately sample data where the frequency is 15,000 Hz (moderately high fidelity—my stereo does 20 kHz, my ears do 12 kHz) requires 30,000 samples per second. Program-controlled sampling can often go no higher than 1000 to 5000 samples per second, so audio monitoring clearly requires specialized hardware and DMA (direct memory access) devices.

When designing a real-time system, you need to consider the performance of the hardware and the operating system. By hardware I mean the processor chip, the bus structure, the memory-management scheme, and the interfaces to the outside world. By operating system I mean the program that directly controls your hardware and acts as the interface between your application program and the hardware.

Hardware

Eight-bit processor chips are ideal for character processing and low-precision analog work. However, they have limited performance when greater precision or address space in excess of 64K bytes is needed.

Sixteen-bit microprocessors match the precision of the most common A/D (analog-to-digital) converters (with 10-, 12-, and 14-bit A/D converters most common). Unfortunately, microprocessors often run into address-space limitations when a large volume of data is needed.

The popular 32-bit microprocessors offer a large, linear address space, fast cycle times, and efficient program-processing characteristics. These are *essential* to success in real-time operations.

A factor in performance that goes beyond the speed of the processor chip is the delays the processor encounters in fetching data from memory. One example of this is the TRS-80 Model 16, which has a relatively slow 68000 processor but which encounters little delay in fetching data from memory because it has memory directly on board the processor. The Exormacs computer uses a higher-speed 68000 chip, but it has greater fetch delays due to the use of a standard (Versabus) memory interface and slower RAMs (random-access read/write memories). A second example is the Universe 68 computer. When using the memory bus (which is also a Versabus), it has one rate of processing. However, when using the 4K-byte cache memory, an onboard fast memory, it has double the instruction-processing rate.

The second hardware factor in designing a real-time system is the system bus. A good system bus allows a range of interfaces as well as sufficient bandwidth so that the system can accomplish all tasks within a reasonable time. If all the interfaces required are on the basic system (as in a single-board computer), the system bus is not an issue. But the variety of real-time applications and the special nature of some of the interfaces deem this unlikely.

Only three design choices are currently available for nonproprietary 32-bit buses: Versabus, VME, and Multibus. Versabus and VME have the largest number of available interfaces because they are older buses. Adapters permit the use of the smaller VME and Multibus boards in Versabus card cages, which gives this bus an additional short-term interfacing advantage.

A real-time system's memory-management design must be as carefully considered as the processor and system bus. Where performance is a critical issue, memory response time must be reduced. Some of the factors that influence memory response time are memory-management logic, bus drivers, dynamic-RAM refresh logic, and error-detection and error-correction circuits.

We shouldn't forget the real-time clock or timer circuit—traditional elements of real-time environments for good reasons. One of these is needed if time-related operations or rigid time intervals are involved. However, time-out logic is also needed to avoid deadlock and other error conditions. For example, in a game that uses multiple sprites (moving graphics image units), where the images associated with two different sprites attempt to affect the same item (say, eating a cookie) but only one can be allowed to do the task, a locking mechanism is needed. Either sprite A is locked out and sprite B has access, or vice versa. Given a bit more complexity, it's possible to have A locked out waiting for B, B locked out waiting for C, and C locked out waiting for A. With everything locked, all activity ceases. One way to detect this condition is a time-out that allows a program to regain control and determine if such a deadlock has occurred. Another way is for a task to release any items it has in case of time-out so that another task can continue.

In many real-time applications, the computer must be connected to a remote device (or another computer) via a serial port. This has become increasingly popular with the many low-cost processors being built into data-collection and display devices. RS-232C and RS-422A are the most common types of connections. RS-422A can operate over longer distances and with better noise immunity than can RS-232C. For example, 50 feet is the limit on an RS-232C interface operating at 9600 baud, but an RS-422A interface can easily run up to 4000 feet at this same rate.

The control lines in RS-422A and RS-232C cables are heavily used in real-time applications to provide essential flow control over data transmission. For many system configurations, read, write, and ground are the only required lines in a connection.

Some real-time system designs employ software routines such as the XON/XOFF sequence (usually Control-S/Control-Q) to control data communication flow. This routine sends a character back up the line to instruct the transmitting system to stop sending data. A second character indicates that data transmission is to resume. Full-duplex data transmission (simultaneous data reception and transmission) requires multitasking capability to monitor the receive data line while transmitting to ensure that a control signal or message is not received that could change or affect the transmission in progress. For those communications ports that do not support full-duplex communications (which prevents the use of the XON/XOFF controls), slower baud rates ensure successful transfers but hurt the real-time power of the system.

Some real-time tasks can be accomplished only by programs that directly control the computer.

The Operating System

Some real-time tasks can be accomplished only by programs that directly control the computer with no intervening operating system. However, as long as your task can tolerate the delay, it is better to use one of the standard operating systems now available.

The ideal operating system would have multiuser, multitasking, and real-time capabilities. Incidentally, multiuser development is advantageous even for single-user systems because it allows the execution of several simultaneous tasks, for example, editing one program while another is being compiled. Unix is an example of an excellent multitasking operating system, although it is not suitable for many real-time tasks. However, modified Unix and Unix-compatible systems that do provide real-time facilities are available. An example is the HP/Unix system, which has a real-time kernel written by Hewlett-Packard that interfaces at the system-call level to Unix. Another example is the Unos operating system.

For real-time tasks, the operating system must let the programmer have control of I/O (input/output) devices, physical memory, task priorities, exception processing, and data integrity. A programmer must control I/O devices to monitor and control the computer's peripherals. PEEK/POKE control is one form of this, but often a task is set up to run when an external condition changes, such as when the user pushes a button or the fire alarm sounds. For this, the system must provide an interrupt facility and the ability to pass control back to a specific user task.

Control over physical memory is needed to avoid swapping and to control data flow. Swapping, the automatic exchange of information between memory and a mass-storage device, can result in a change of memory location or, worse, in significant delays when that fire alarm sounds and the service task cannot be swapped back into memory. The ideal operating system would let the programmer inhibit swapping and identify and control physical-memory areas for buffering data from I/O devices. Sharing these areas between tasks can be essential when one task performs data input, a second scales the data, a third records the normalized data to disk, a fourth analyzes data for statistical evaluation, and a fifth uses the current statistics to control an external device. Shared memory and asynchronous operations are needed for this to work efficiently.

In the preceding example, the programmer must be able to control the priorities of tasks to make sure that

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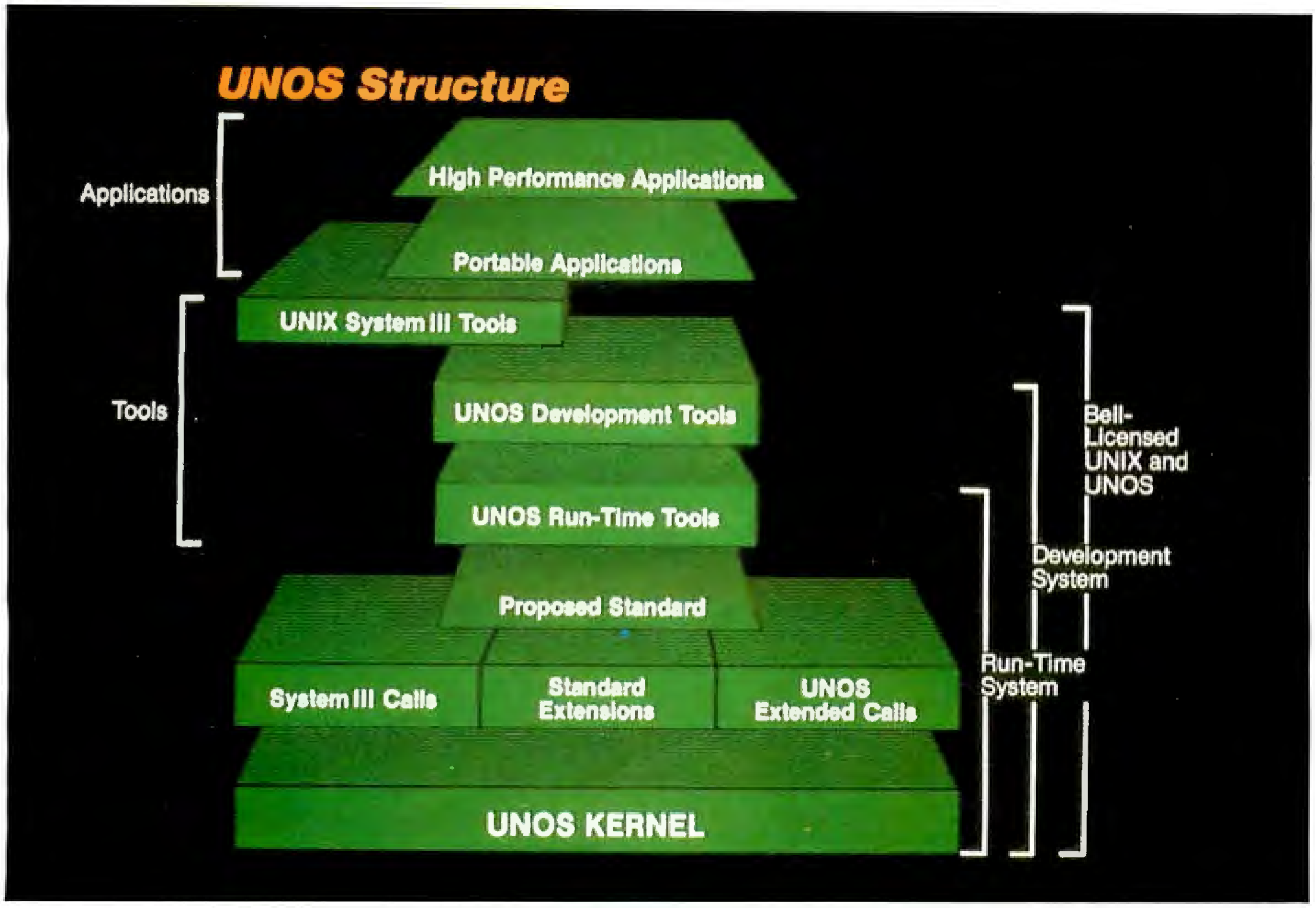

Figure 1: *An example of task scheduling by the Unos operating system.*

the real-time tasks are not stopped in favor of a less important task. Priority control mechanisms let the programmer decide and control which tasks get the processor. In the ultimate real-time system, each task is guaranteed a worst-case delay to ensure that the task has enough time to complete its job when activated. As with any other real-world situation, Murphy usually gets his way, and this has to be taken into consideration when setting task priorities. Some tasks simply may not be completed.

An operating system should provide dynamic priority-scheduling of tasks. In Unos, a Unix-like operating system, each task has a ceiling and floor priority with the numeric value of the ceiling greater than or equal to the floor. Normal timesharing users get a 100-10 assignment. A user can lower either value, but only privileged users can raise the values. If a timesharing task becomes compute-bound (completes a time slice without waiting for I/O), it is automatically dropped in priority so it will not interfere with interactive users. The example in figure 1 starts with the real-time task running at priority 200. A real-time task would have the floor and ceiling equal and swapping disabled for that task. When the task at the higher 255 priority is ready to run, it preempts the 200-level task and starts running. When both of these block, the processor is again available to time-slice between the timesharing users at priority 100. With these tasks blocked, tasks at levels 10 and 5 get an occasional shot. For tasks on the same level, round-robin scheduling is used, with either time slicing or blocking being the method of passing control. If a real-time task becomes compute-bound, it can use all the resources it needs to the exclusion of other tasks. This is essential in giving real-time tasks the control they need and explains why the raising of priority levels is a privileged operation.

If no abnormal conditions existed, exceptions would not occur, and real-time programming would be incredibly simplified. But the nature of real time ensures that many error conditions may occur. These require an additional level of asynchronous control by the programmer. In process-control-related tasks, lost control is fatal to the success of the application. This means checking for all obvious error conditions related to program operations (e.g., I/O errors and arithmetic overflow/underflow). Also, the program must be prepared to trap a number of other error conditions that are not related to its immediate operations. This includes conditions such as communications-line errors, disk and/or memory errors, and power failures.

Programmers can maintain control over data integrity if the operating system forces critical data to a disk in the event of a system failure. A power failure is only one example of an external event that can have a severe

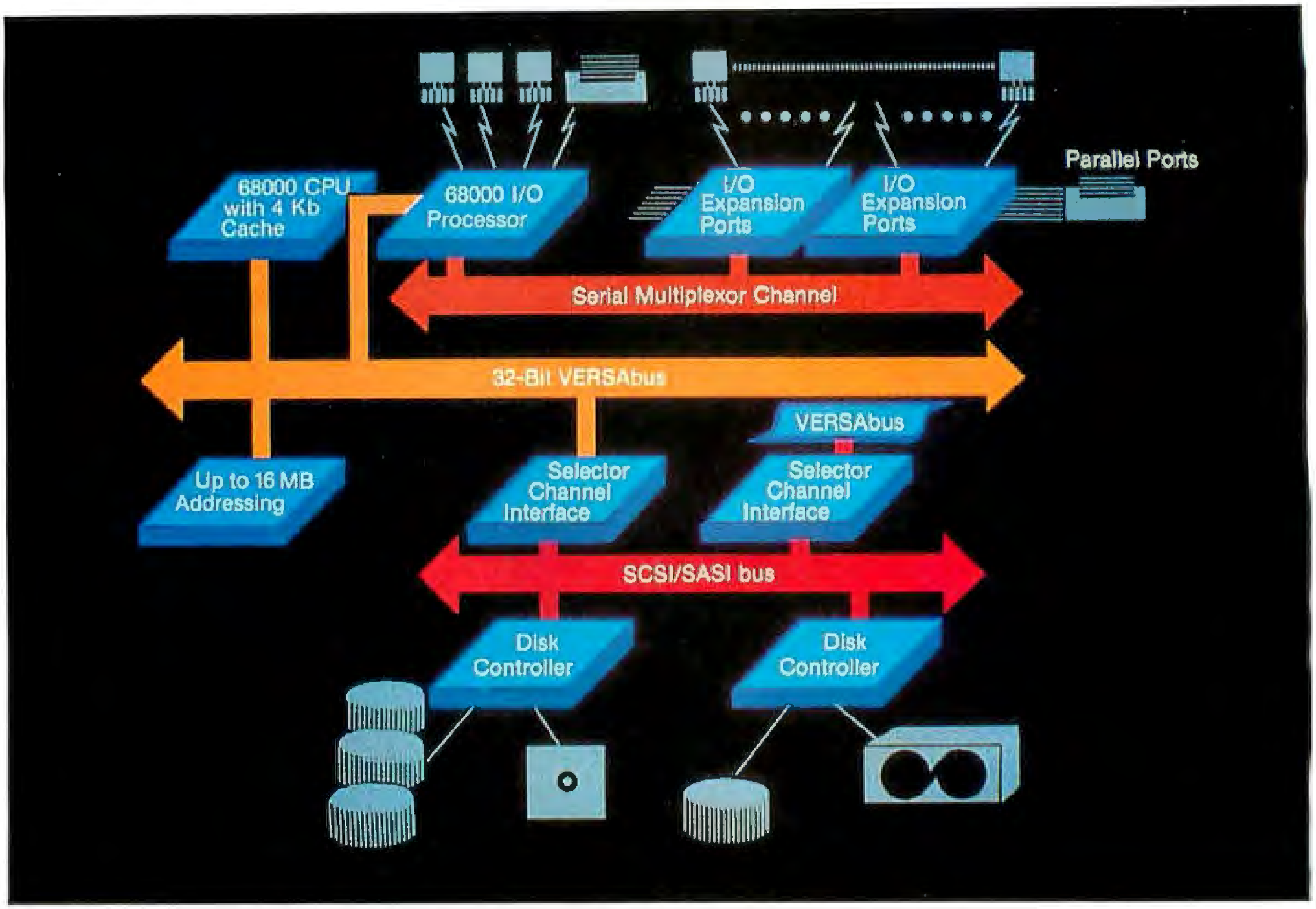

Figure 2: *The components of delay in a computer as it attempts to respond to a real-time event.*

impact on the integrity of the data being collected. You can expect to lose RAM to this or other failures; so, for real-time processes, a mechanism is needed for determining what data has been lost and what data is still valid. The worst case is exemplified by the many systems that have actually lost the integrity of their entire disk-file system after an abnormal termination. In that case, all data is lost, even that successfully written to and stored on disk. This can be avoided with data-integrity features in the operating system.

Performance Measurement

Two major areas of performance measurement are interrupt latency and context-switching time. Interrupt latency is the longest time that the computer takes to act on a single interrupt. Only the highest-priority interrupt (which is usually called nonmaskable because it must be acted upon, that is, it cannot be "masked out") is always acknowledged within the interrupt-latency period. Lower-priority interrupts must wait if a higher-priority interrupt is active.

Context-switching time is the time required to stop execution of task A, save that task state, and restore the state of and start task B. This switch might occur as a result of an interrupt, a synchronization signal between tasks, or a time slice. Note that the number quoted in some microprocessor ads simply reflects the switch between the user mode and system mode and does not include the overhead needed to enter a second user task.

If the real-time application requires sampling data at a high rate, the context-switch transition can be a limiting factor. A millisecond (ms) response time would limit processing to 1000 samples per second. To improve this, data can be buffered in the driver (with 50-microsecond (μs) overhead, or a limit of 20,000 samples per second) and the application task given control on every *n*th sample. Notice that the limits of 1000 or 20,000 samples per second imply that the system performs no other functions, no time-of-day updates, no disk I/O, and no computations. This, then, does not provide a practical limit but rather a way to measure the percentage of utilization that a specific application requires.

The interrupt latency and context switching, along with other factors such as the application program, determine the elusive and overused term—response time. It entails a few measurable time delays and a number of application-code-related delays. The result is a response-time measure that becomes quite dependent on the actual application, and it cannot be predicted in advance.

In figure 2, the delays encountered by an external interrupt are

1. The hardware delay in signaling the processor. Daisy-chaining of interrupts can delay this, as can the current bus cycle. Interrupt

masking, disable logic, and priorities can all add delays. If the interrupt is not of high enough priority, or if it is currently masked or disabled, it will wait.

2. Saving the previous state of the processor on a system stack somewhere. Operating systems often take control at this point to save even more information to make sure the previous state can be recovered and continued.
3. The device driver, which uses some convention to indicate the occurrence of an event. It then releases control, with some additional overhead needed to restore the previous state of the system. The previous state may be the service of another interrupt; this could continue for a while, with various delays and additional interrupts, before any processing occurs at the user's task level.
4. Operating-system housekeeping. These delays can be quite substantial. (One minicomputer "real-time" operating system I have used quite often can produce multiple minutes of delay at this point!) The highest-priority task that is ready to run needs to be identified now, and this may require a context switch. The context switch saves the state of the previous operating task and allows a new (presumably higher-priority) task to take control. This time is one that can be measured.
5. The user's task itself. If swapping from disk is required to load the user's task, the delay may be greater than 100 ms.

A number of techniques can improve performance. By moving the sampling logic to a DMA controller and moving blocks of data to main memory with interrupts every 100th or 1000th sample, the host processor has more time for its operations. Similarly, addition of hardware to perform floating-point calculations or array processing can provide additional performance boost. Finally, the disk-interface hardware can limit the data logging and output rate. For a disk, system facilities that allow an application direct control over disk blocking, and the creation and use of contiguous disk files, can significantly increase performance. For some microsystems, all the files are contiguous and are limited in size and dynamic growth by this characteristic. In larger systems such as Unix, this reverses, with dynamic growth given the preference and little or no facility for contiguous disk-file control. Contiguous files are favored because the use of physically adjacent blocks of disk space allows the application to transfer data with just rotational delays, usually 2 to 10 ms, rather than the 10- to 100-ms seek delays. Faster disks and disk caching can also provide a way to deal with this limit on performance.

Conclusion

Both the systems manufacturer and the application developer must fully realize the relationship between the hardware and operating system if they expect to develop products for the real-time world. While processor performance is only one element of this, careful hardware design using higher-performance buses and accelerators such as cache, memory management, and arithmetic processors is quite critical. Once the hardware is defined, the operating system (and language used) must be able to take advantage of that hardware and give the programmer efficient control over the real-time environment. Finally, the application program must take into consideration not only all the hardware characteristics but those exceptional conditions that are almost guaranteed to occur. This will ensure that the application does not get caught in slowdowns related to memory control, addressing, priority, device drivers, abnormal conditions, and/or other applications that should not be affecting the real-time process. ■

James Isaak (983 Concord St., Framingham, MA 01701), the director of product marketing for Charles River Data Systems, has an M.S.E.E. from Stanford University. He enjoys camping, skiing, and canoeing. He also likes to spend some of his leisure moments with personal computers as applied to genealogical work.

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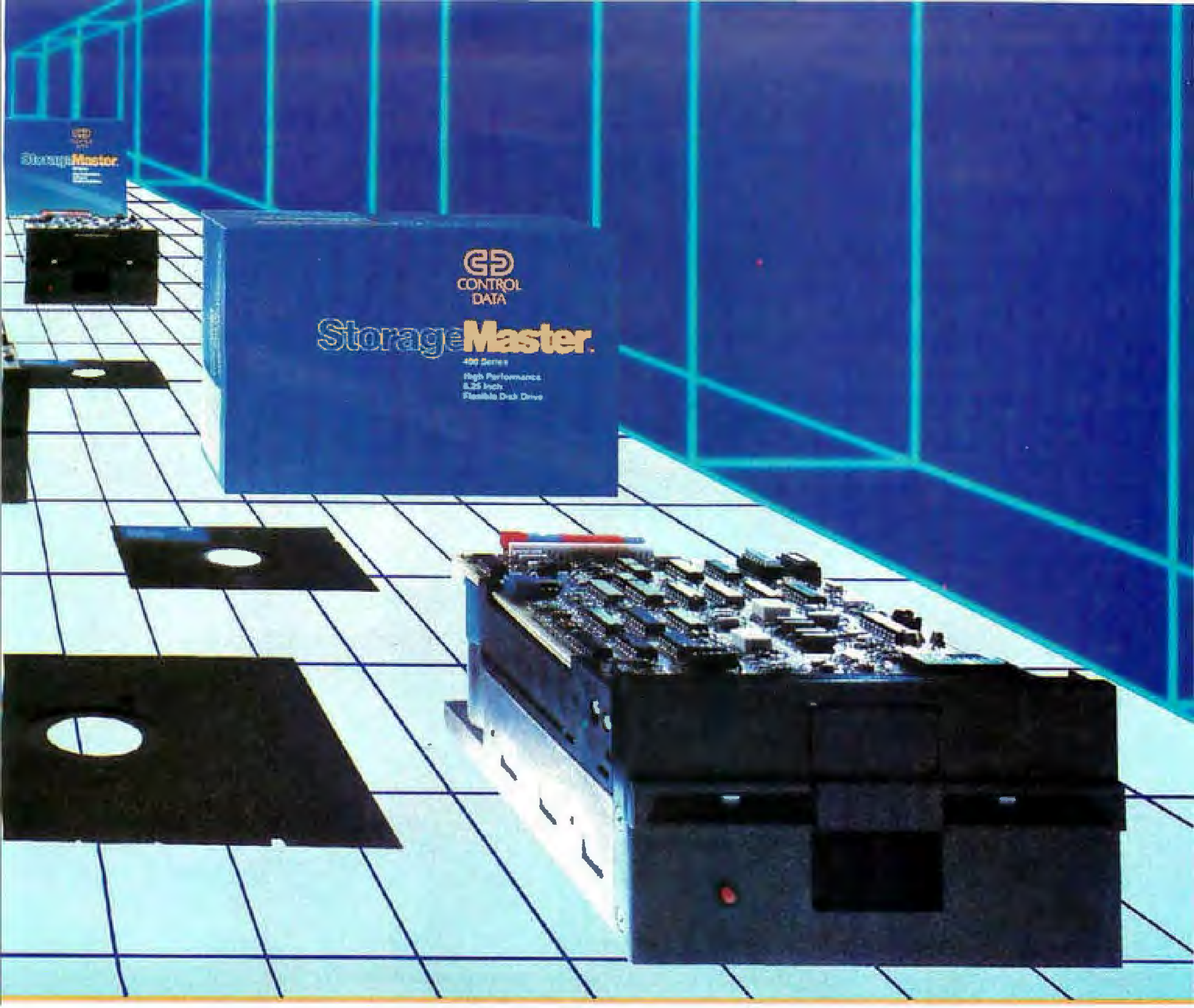
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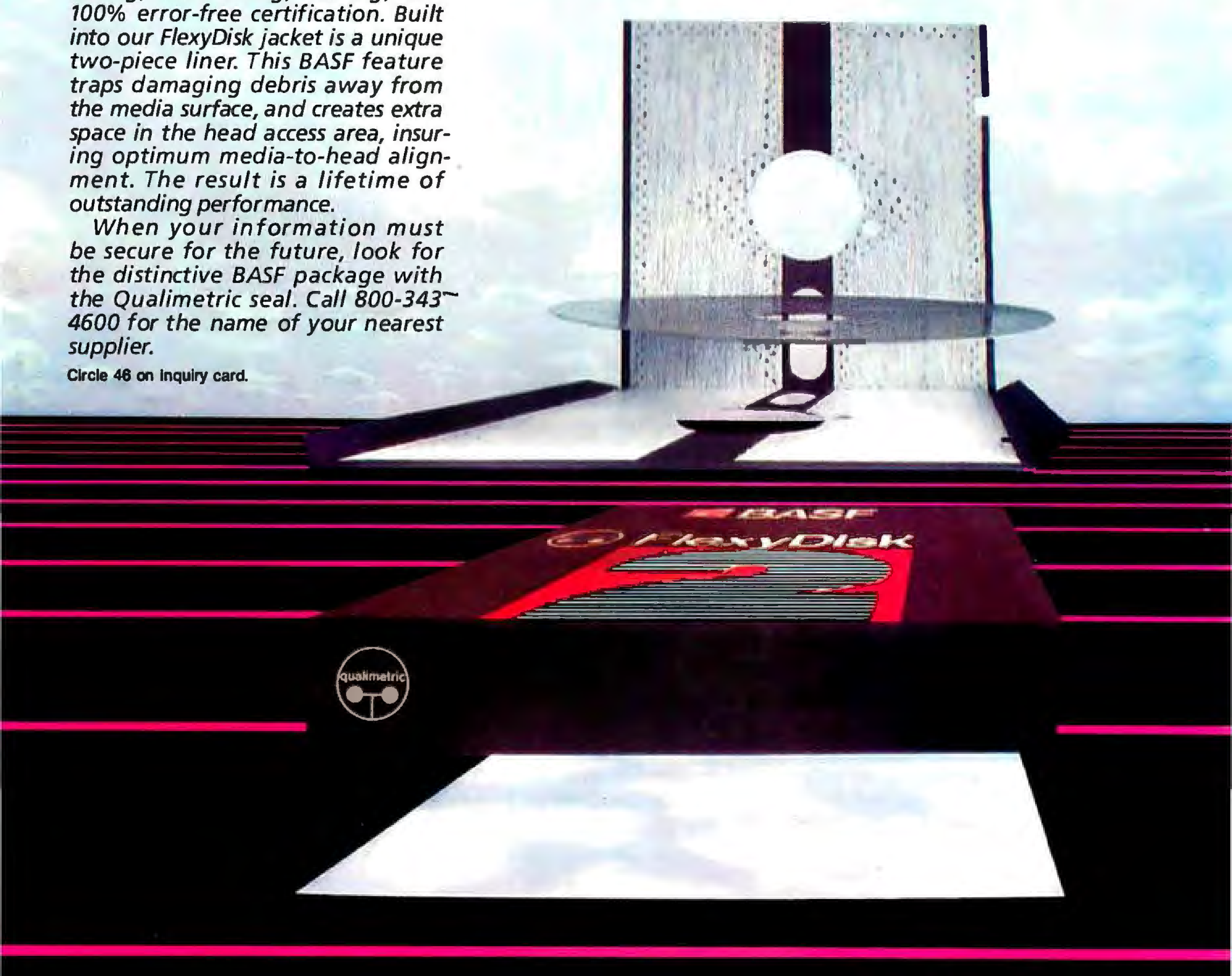

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Interfacing for Real-Time Control

Appropriate interfacing simplifies design of a telescope system

Russell M. Genet, Louis J. Boyd, and Douglass J. Sauer
Fairborn Observatory

Interfacing microcomputers to external devices becomes more important when control signals must be generated in rapid response to external events in the real world. Although a nearly direct connection of microcomputers to external control devices is simplest from a hardware viewpoint, adding some hardware "smarts" to the interface often can reduce software complexity. A large variety of commercial plug-in cards facilitates the microcomputer-to-control-device interface, but use of these cards requires either a microcomputer with slots for cards (e.g., the Apple II or IBM Personal Computer) or a standardized bus such as the S-100, the STD bus, or the Q-bus.

Using smart interface hardware with a real-time control system often can reduce software work because a high-level language can be used. Without such an interface, much of the software may have to be done in assembly language due to the fast, time-critical requirements for system response. However, increasingly sophisticated non-bus single-board computers are giving bus-oriented systems competition in some applications.

In addition to the considerable gains realized from traditional trade-offs between hardware and software in the microcomputer control system itself, further gains are possible if the real-world system to be controlled can be adapted somewhat to live gracefully within the limitations of microcomputer control systems. The ability to design from scratch the external system to be controlled and its microcomputer control system can significantly reduce the complexity of both the control system's hardware and software. With existing systems this is not always possible, but modifications in one or two critical areas are worth considering.

We will illustrate the trade-offs involved in real-time control interfaces with the two automatic telescopes at the Fairborn Observatory. The system at Fairborn Observatory West (in Arizona) is based on a non-bus single-board computer, and the system at Fairborn Observatory East (in Ohio) utilizes the STD bus. Both systems use interface hardware to simplify the software. The telescopes and instruments (photoelectric photometers) in both systems have been designed or modifed to make microcomputer control as simple as possible.

Heretofore, the few automatic telescopes in the world that could measure a sizable number of different stars were extremely expensive and utilized mainframes or minicomputers. By using microcomputers, designing the telescopes specifically for microcomputer control, and making a careful trade-off between control-system hardware and software, we reduced the effort and cost by one or two orders of magnitude. This is the bottom line of this article—trying to solve control-system problems with microcomputers and appropriate hardware/software trade-offs. You may find, as we have, that the low cost and simplicity of a well-designed microcomputer-controlled system can benefit an entirely new universe of users. In our case, microcomputer control has moved automatic telescopes from the large observatories to the realm of the small college and advanced amateur observatories.

Hardware and Software Trade-offs

There is a natural tendency, often expensive and occasionally disastrous, to make hardware as simple and inexpensive as possible and to place the burden on software development. Hardware costs are both immediate and obvious; software costs are off in the future and less obvious, especially to optimists. Many real-time control projects have been abandoned in failure when it finally became clear that the software programming would take much more time and money than originally anticipated.

Taking the burden off software development and placing it on interface hardware is what standardized buses with plug-in slots are all about. Such bus-based microcomputers can cost more than those without standardized slots of some sort, but this investment can open up the world of ready-to-go plug-in interface cards. Such cards come fully assembled and debugged. The better ones have excellent documentation and have been burnt in.

Many of these interface cards are very intelligent, with their own microprocessors and machine-language programs in EPROM (erasable programmable read-only memory). The software work has been done by the card manufacturer, and the cost spread out over hundreds or thousands of users. Smart interface cards are often used by control-system designers to do the fast, repetitious, and mundane tasks such as controlling stepper motors and reading optical angle encoders. By delegating these nasty tasks to the off-the-shelf smart cards, it is often possible to program most or all of the "custom" software in a convenient, high-level language such as BASIC. Picking the right bus and the best interface cards available for the bus can often drastically reduce the cost and time spent in custom software development. This can be the difference between the success and failure of an entire project.

In making hardware/software trade-offs, it is not only the digital hardware of the control system and its software that are fair game, but also the hardware and the concepts behind the system being controlled. Often the greatest savings and simplifications in the total system will be made by "invading" these sacrosanct areas. This vital point is illustrated by our real-time control systems, the Automatic Photoelectric Telescopes (APTs) at the Fairborn Observatory. (Details of the APT systems are described in the text box "Microcomputers and Variable Stars" on page 140.)

The Earth's rotation complicates the problem of locating stars and necessitates our tracking them as they appear to move across the sky. This problem can be somewhat simplified by making one of the two perpendicular axes of rotation of the telescope parallel with the rotational axis of the Earth. This axis of telescope motion is appropriately called the *polar axis*, and angular rotation about this axis is measured as *right ascension*. Motion about the other axis is measured as *declination*. Once a star is found, it can be tracked by moving the telescope at a constant rate about the polar axis only.

Taking the burden off software development and placing it on interface hardware is what standardized buses with plug-in slots are all about.

The position of a conventional computer-controlled telescope is sensed by high-resolution (and expensive) optical angle encoders on each of the two axes of motion. However, for different positions of the telescope, there are pointing errors introduced in the portion of the telescope system beyond the optical encoders. These errors, which are a function of telescope position, include mechanical flexure of the optical assembly and varying atmospheric refraction. In the conventional control system, these errors, which can be quite complex mathematically, are modeled and repeatedly solved as the telescope changes its position. Repeating these complex calculations one or more times per second usually requires sophisticated machine-language routines, an interrupt-based control system, and 16-bit microcomputers or minicomputers.

In the Fairborn APTs, the expensive optical encoders have been eliminated, there are no complex calculations to be made, programming is in BASIC, there are no interrupts, and 8-bit microprocessors are more than sufficient. We have achieved this by being willing to design an unusual telescope well suited to microcomputer control.

Three design decisions were particularly crucial. First, we needed a telescope mount totally free of backlash and a drive system without clutches. We used only a single stepper motor per axis, which enabled movement of the telescope in such a manner that the computer could track the telescope's position without feedback from optical encoders. Second, we used a permanently mounted photoelectric photometer not only to make the scientific measurements on variable stars but also to assist in locating the stars and centering them in the optical system. This meant that the complex calculations for accurate pointing were not needed because even if the telescope were not pointing near the star initially, the system could hunt for it with its photoelectric "eye." Finally, with a pulse adder, we electronically implemented the function of turning the telescope to follow stars, which significantly simplified the software. Although decidedly unconventional, the system can find any star and center it in the photometer with an accuracy of almost 1 part per million—just like systems costing 10 or even 100 times as much.

As an example of a more traditional hardware/software trade-off, consider microcomputer control of stepper motors. At one extreme, a microcomputer can calculate the bit pattern needed to drive each individual phase of the stepper motor. Typically, this machine-language routine might be embedded in a larger BASIC program or might be programmed in C or FORTH. Often, it is necessary to *ramp* the steppers up to a high speed and then ramp them down again. A chip or two added to the hardware can simplify the software considerably. For instance, Hurst Manufacturing makes a one-chip stepper controller/driver that uses TTL (transistor-transistor logic) pulses for stepper motion and direction on input and has a direct connection for small steppers on output. Sigma Instruments makes a two-chip set (along with a few discrete components) that takes a pulse stream (of some length) as input and provides a ramped pulse stream as output. Pulses are "borrowed" from the beginning to provide the ramp up, and the exact number of borrowed pulses is "added" to the end to provide the ramp down.

At the smart extreme there are intelligent stepper controllers, of which the Whedco STD card is a prime example (see photo 1). From a high- or low-level language, the Whedco controller can be told the start speed for a stepper, the ramping acceleration, the top velocity, and the initial position. Any time thereafter, a simple command, such as move −1,235,476 steps, is executed exactly, including ramp up, slew, and ramp down, bringing the stepper to a smooth stop exactly where desired. Both hardware and software flags are available to signal when movement is complete. An onboard register keeps accurate track of the total moves and, hence, the current position. Unramped moves and single steps also can be commanded. In-motion stops, either ramped or immediate, can be commanded at any time. Although the Whedco controller has an onboard Z80 and its own program in EPROM, this is totally transparent to the user, and the controller appears just as an I/O (input/output) port to the user who issues the high-level commands.

As mentioned earlier, Fairborn APTs use two steppers, one on each of the perpendicular axes (right ascension and declination). Employing two smart stepper controllers, we can move the telescope directly between two stars by issuing two very brief commands. However, by enabling the telescope to go in one of eight directions at any one time and breaking up the move between two stars into two separate segments (with the telescope coming to a momentary stop between the segments), it is possible to get by with a single stepper controller. This is a case in which the overall concept, telescope movement, was made more complex, and the total system efficiency was reduced (imperceptibly) by adding a "waypoint" stop in every move. For systems using smart stepper controllers, this saves hardware money; for systems with software ramping, the touchy simultaneous two-stepper motor problem is reduced to the easy one-stepper problem.

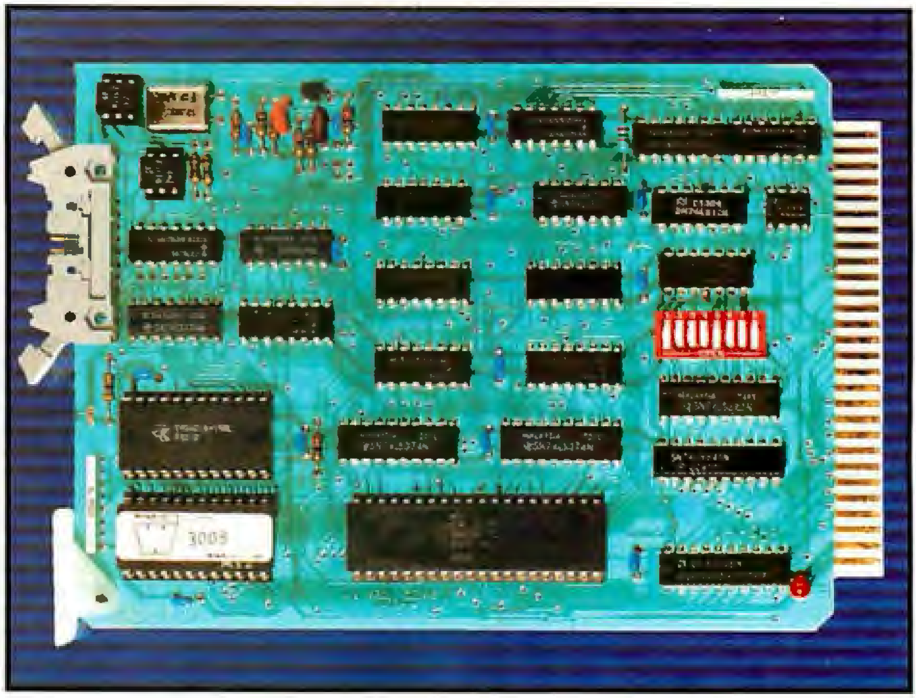

Photo 1: *The smart stepper controller from Whedco Inc. for the STD bus contains its own Z80 microprocessor and machine-language program in EPROM. Such smart boards can do all the fast "dirty" work, letting the system's main processor loaf along in a high-level language on an 8-bit microcomputer.*

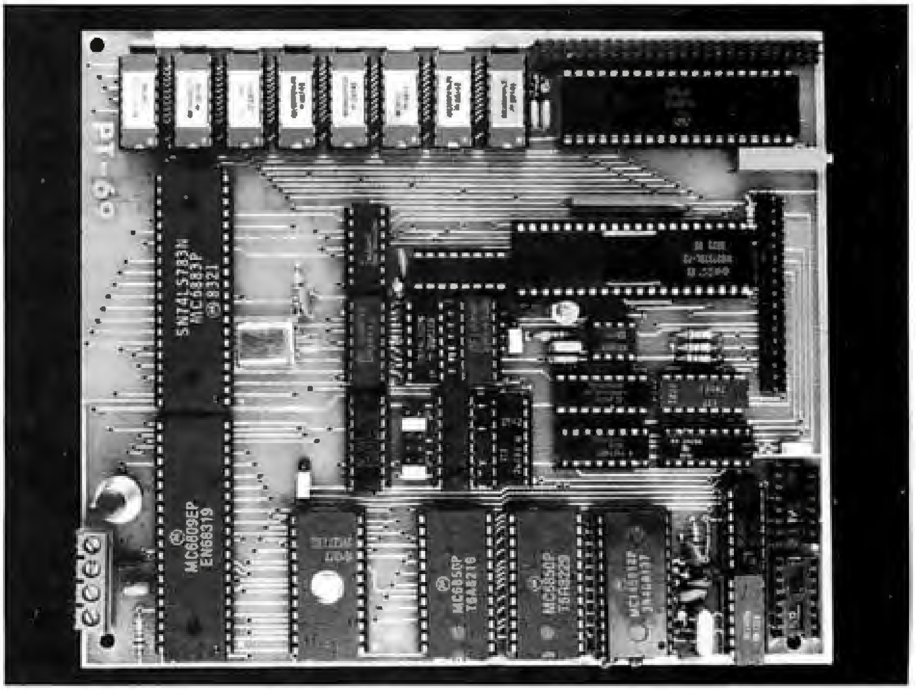

Photo 2: *The single-board computer from Peripheral Technology has everything needed to run an automatic telescope—a rather complex control system. The board has a 6809E processor, RAM, floppy-disk controller, real-time clock/calendar, and two serial and two parallel ports.*

Microcomputers and Variable Stars

Photoelectric photometry, a major area of astronomy, is concerned with the highly accurate measurement of the brightness of stars and other astronomical objects in relation to time. Due to the high quantum efficiency and wide bandwidth of the detectors used in astronomical photometry, smaller telescopes can obtain highly accurate results on stars as faint as tenth magnitude. As there are literally thousands of scientifically interesting stars this faint or brighter, astronomers at small colleges and advanced amateurs are observing variable stars from locations all over the world. Much of this is done on an international cooperative basis, with observations from many astronomers being consolidated at a central location, such as Douglas S. Hall's analysis operation at Vanderbilt University. Most of these observers, and many persons just interested in this amazing backyard science, are members of the International Amateur-Professional Photoelectric Photometry Association (IAPPP). The IAPPP includes 500 people from 42 countries, almost evenly split between amateurs and professionals. The observational results of their activities are published in the leading astronomy journals.

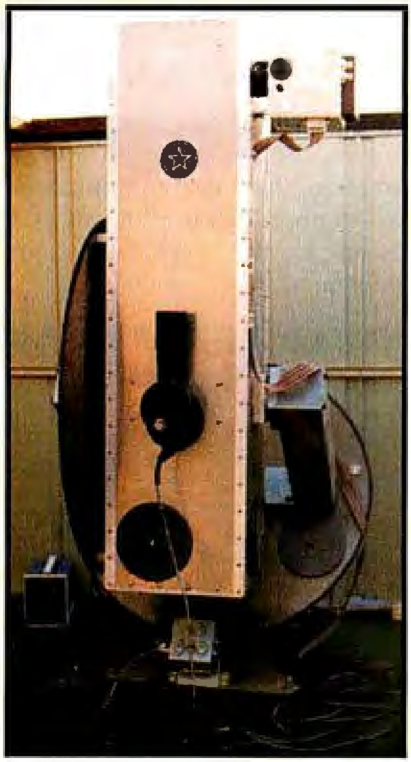

Photo 1: *The original Automatic Photoelectric Telescope (APT) at the Fairborn Observatory West in Phoenix, Arizona. The photometer that "looks" at the stars is the box attached to the top right of the telescope. The large-diameter disk on the left side of the telescope moves the telescope in declination while the large disk at the bottom rear moves the telescope in right ascension. This telescope finds, centers, and measures stars automatically.*

A variety of astronomical objects is measured by these intrepid small-observatory photometrists. One of the most interesting classes of stars being observed is the RS CVn binary stars. These stars have very large groups of sunspots, or more accurately, starspots. These starspot groups move slowly around the stars and wax and wane like the spots on our sun, except much more dramatically. Discovering and tracking these stars requires observations spread over months and years. The large observatories simply do not have the necessary telescope time, so this exciting field has been pioneered mainly at small observatories in the backyards of amateurs and on small college campuses.

It is interesting to watch photoelectric observations being made at a small observatory. The variable star of interest is located and centered in a very small diaphragm (to exclude the light from all other stars), and the photons from the star are counted for 10 seconds and recorded. This may be repeated in several different color bands. The same procedure is repeated for a nearby nonvariable comparison star, another nonvariable check star, and one or more sky locations without stars. The entire sequence is repeated perhaps three times; after about 30 different measurements spread over 20 minutes or so, the astronomer moves the telescope to the next group of stars and does the same thing all over again. The process of photoelectric photometry is described in considerable detail in Photoelectric Photometry of Variable Stars *(see reference 3).*

No microcomputer devotee can watch this highly structured and repetitious observing process without immediately considering how microcomputers might be used to aid the busy astronomer. Within months of the first photoelectric observations at the Fairborn Observatory, one of the early TRS-80 microcomputers was used to record and analyze (on line) the photoelectric findings. This system has been described in great detail in Real-Time Control with the TRS-80 *(see reference 1). Four years passed before the much more challenging and difficult problem of completely automating the observations in a low-cost, microcomputer-controlled system was successfully completed by Louis Boyd. In early November 1983, the Automatic Photoelectric Telescope (APT) at Fairborn Observatory West made its first all-night observations without human assistance. (Figure 1 on the next page is a pictorial representation of the APT in photo 1.)*

APTs are discussed in general in Advances in Photoelectric Photometry *(see reference 5). The hardware and software details of the Fairborn Observatory APTs are described in* Microcomputer Control of Telescopes *(reference 4). The APT in photo 1 is moved by two Slo Syn steppers from Superior Electric Co. that drive small antibacklash worm gears. These in turn drive large disks (32 inches in diameter) with sprockets and chains. Without any preloading, there is no perceptible backlash in the drive system of this telescope—an important design consideration that led to significant simplifications in the control-system hardware and software. The APT derives its initial position information from limit switches in the southeast corner of its travel range. The conventional, and expensive, optical angle encoders have been eliminated from this system, and the permanently mounted photoelectric photometer (which is needed to make the actual measurements) does double duty by helping the system locate and center the stars. This latter feature of the APT resulted in the greatest hardware and software simplifications.*

The operation of the APT can be most easily understood by considering its normal sequence of actions. In the early evening, the system repeatedly calculates how far the sun is below the horizon. When it is 10 degrees below, the main APT program is called. The system contains a database for all the groups of stars observed throughout the year, and the first task is to calculate which of these groups of stars will be within the night's "observing window" and when they will be there. A small subroutine then accurately positions the telescope on its limit switches in the southeast corner of its range. An electronically separate clock is then turned on and, at this precise time, the APT shifts into celestial coordinates and tracks the stars in their motion across the sky. Although providing a hard-wired stellar rate *drive meant a slight hardware complication (an electronic pulse adder), making the sky "stand still" from the viewpoint of the software probably reduced the software task by approximately a factor of four.*

The APT then moves to the first, westernmost, group of stars. As mentioned earlier, this movement is made in two distinct segments, with a very brief stop between each segment. When the telescope stops in the area of the sky near the first star, it actually may be some distance from the star. Conventional systems get much closer by measuring the exact position of the telescope at its two axes with highly precise optical angle encoders and then make complex corrections to this position to account for flexure of the telescope, refraction of the atmosphere, etc. However, the APT does not worry about not being almost exactly on the star; instead, it starts an immediate square spiral search using its photoelectric photometer eye. As soon as the star is found, the same eye is then used to center the star in the diaphragm, and the photoelectric measurements begin. As mentioned earlier, the final pointing accuracy of the APT is about 1 part in 1,000,000. This great economy is achieved by using a carefully designed microcomputer control system and photometer to "close the loop" directly on the stars themselves. Dawn finds the APT making its measurements on the last group of stars in the east. The telescope then returns to its home position and the roof is closed.

Not unexpectedly, the APT is having an impact on astronomy. One of the foremost designers and builders of large astronomical telescopes, Dr. Frank Melsheimer at DFM Engineering, announced the production of its first mount that costs less than $100,000. DFM Engineering now produces the only modest-sized, commercially made telescope mount specifically designed for microcomputer control. It is a clear case of microcomputer control-system requirements affecting the basic design of the system being controlled; consequently, a completely new realm of applications has opened up.

Instead of using conventional worm gears, this mount uses steel friction disks 15 inches in diameter to achieve zero backlash without preloading. Large aluminum castings make the mount unusually rigid so that even the heaviest vibrations die out in a fraction of a second. As a result of these special features, steppers under microcomputer control can rapidly decelerate and stop exactly where desired without the uncertainties introduced by gear backlash or telescope vibration and flexure. Because APTs make many thousands of sudden starts and stops per hour, such a mount is really a necessity. And in less demanding applications, a highly rigid mount free of all backlash is always a pleasure to use.

APTs do not need a human eye to see and center stars. As long as a photometer can "see" the stars, the system will work. Gerald Persha at Optec Inc. is developing a low-cost K-Band photometer that operates in the near infrared. The sky at this wavelength is about as dark during the day as it is at night, so an APT equipped with such a photometer can carry on its observations of late-type variable stars (such as

Textbox continued on page 142

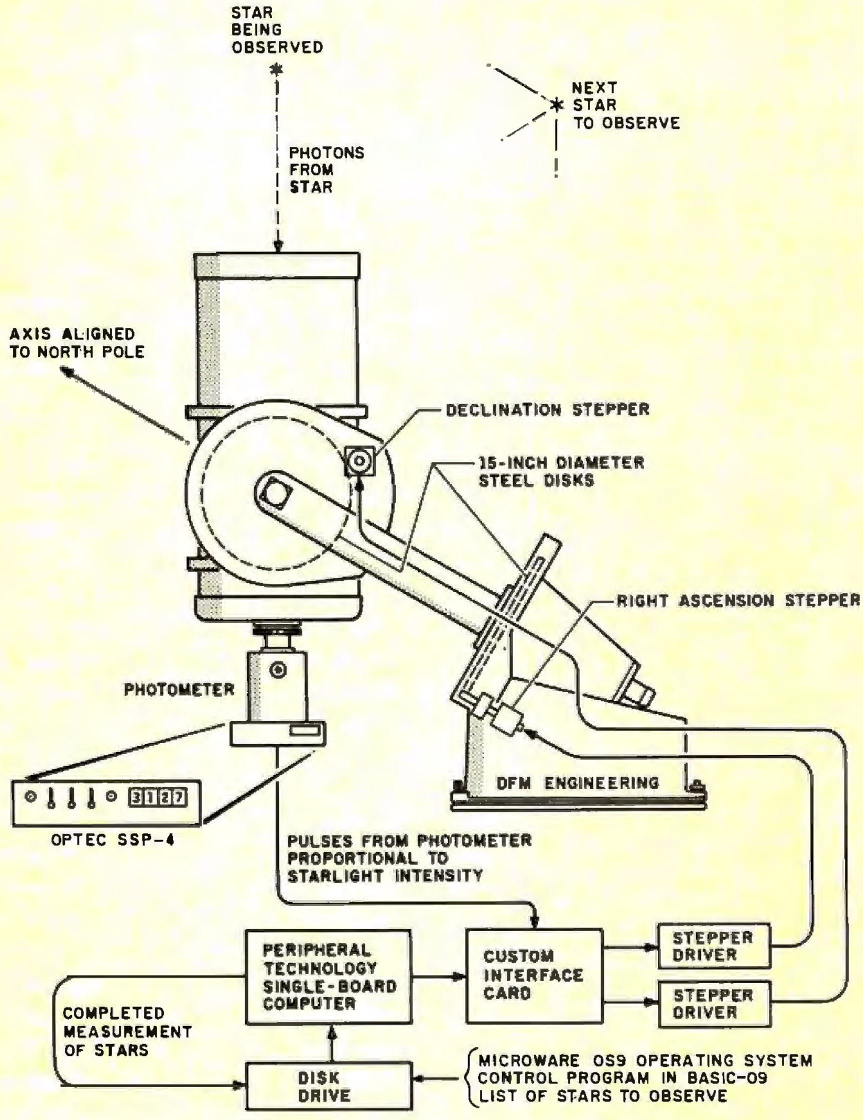

Figure 1: *The second-generation Automatic Photoelectric Telescope (APT) designed at the Fairborn Observatory is controlled by a single-board computer. The telescope system uses a mount specifically designed for computer control. The mount uses direct-contact friction drive on steel disks to avoid the backlash and preloading problems associated with gears. This freedom from backlash greatly simplifies the software. The computer control system moves the telescope close to the star to be observed, and the photometer "eye" is then used in a search pattern to find the star and center it exactly. Measurements are then made of the brightness of the star. This procedure is repeated automatically on many stars each night, and gradually a record of the changes in the light intensity of the stars is built up.*

Miras) in broad daylight. The combination of DFM Engineering's new mount, Optec's near-infrared photometer, and Schmidt-Cassegrain optics is being used in a new generation of APTs.

Finally, it should be noted that a large, 1-meter (primary mirror diameter) APT is being developed by a group of amateur and professional astronomers. The finished 1-meter mirror has been donated to the project by the University of Illinois, and DFM Engineering has completed the preliminary design of the mount. The control system and software will be essentially identical to those that run the small APTs at the Fairborn Observatory. As at Fairborn, the observing will be done by a microcomputer rather than by a human astronomer. However, instead of observing variable stars, the 1-meter APT will make precise photoelectric measurements of variable quasars at the far edge of the observable universe. These most luminous of all objects in the universe pour out more energy than a hundred regular galaxies, yet they significantly vary their output of light in a matter of weeks or months. This can only mean that the source of this energy must be very small. By tirelessly observing these variable quasars night after night, the 1-meter APT with its microcomputer real-time control system should make an important contribution to our understanding of the prodigious energy source of these mysterious quasars. Paying attention to real-world interfacing can have important dividends.

Buses and Single-Board Computers

We feel that selecting the right bus-based or single-board microcomputer for any given real-time control task is relatively straightforward if prejudices not related to real-time control can be set aside. If the task is reasonably well defined and will not be changing in the future, and if a number of essentially identical systems are to be made at low cost, use a single-board computer if it will do the job.

A single-board computer we particularly like and have used for automatic telescope control is a 6809-based one made by Peripheral Technology (see photo 2). This board has a 6809E microprocessor, 56K bytes of RAM (random-access read/write memory), 4K bytes of EPROM, a floppy-disk controller, two serial and two parallel ports, and a real-time clock. If this meets your needs, you can get a fully assembled and tested system; if you need more, then you might consider a bus-based system with plug-in slots.

For convenience, we'll discuss buses in three broad categories: hobby, personal computer, and industrial control. Hobby buses certainly include the very popular S-100, which has done much to make the 8080 and Z80 processors well known, and the SS-50 bus, which remains a favorite of fans of the 6800 series. Categorization as a "hobby bus" simply means that these buses often are favored by homebrewers.

People who want a personal computer with a wide selection of plug-in cards are really limited to the Apple II, the IBM Personal Computer, and their very compatible counterparts. If the real-time control task at hand is not overly difficult, or if one of the microcomputer systems previously mentioned is adequate for the task, then it makes a lot of sense to use one.

However, if the real-time control job is a tough one, if the system is to be in an inhospitable environment, or if you desire to tap the full potential of what is available off the shelf for real-time control, you should turn to the buses used by industry in its control systems. Good examples of industrial buses are the STD bus, the Q-bus, and the Multibus.

The STD bus is probably supported by the greatest number of card manufacturers (about 100) and is compatible with the widest selection of cards (nearing 1000) of any bus or computer system. The card selection is particularly rich in the area of such real-time control tasks as smart stepper controllers, optical encoder interfaces, and DC servo interfaces. The STD bus is used mainly in industrial control, with one interesting exception: portable computers.

STD-bus cards are small in size, only 4½ by 6½ inches. Microstandard took advantage of this small size to build a 10-slot portable computer, the M-6000, and also the low-cost M-3000, which has four vacant STD-bus card slots. A large portion of our STD-bus development and all our word processing at the observatory is done on a Microstandard M-6000.

Although there are 16-bit STD-bus systems, the STD bus is primarily an 8-bit bus that favors the Z80 processor and CP/M. It gets its power and popularity from its wide variety of smart peripheral cards.

For greater crunching power, the Q-bus and the Multibus are good choices. For those who have been brought up on DEC (Digital Equipment Corporation) operating systems, languages, and features, the Q-bus is a natural choice. Although the first LSI-11 microcomputers were somewhat slow compared with their minicomputer relatives, speeds have increased considerably with the LSI-11/23, the LSI-11/73, and now the MicroVAX. Cards for the Q-bus were somewhat expensive a few years back, but competition has brought prices down. The design of a Q-bus-based mobile telescope-control system is discussed in some detail in *Microcomputer Control of Telescopes* (see reference 4).

Interface Hardware

The large number and great variety of interface cards available to real-time control system developers precludes any sort of comprehensive treatment in this article. Rather than even attempt a broad look, we have chosen to consider STD-bus cards and, from the almost 1000 different STD-bus cards, only a dozen that we have had personal experience with at the observatory. For convenience, we have divided these cards into categories: onboard microprocessor, straight-

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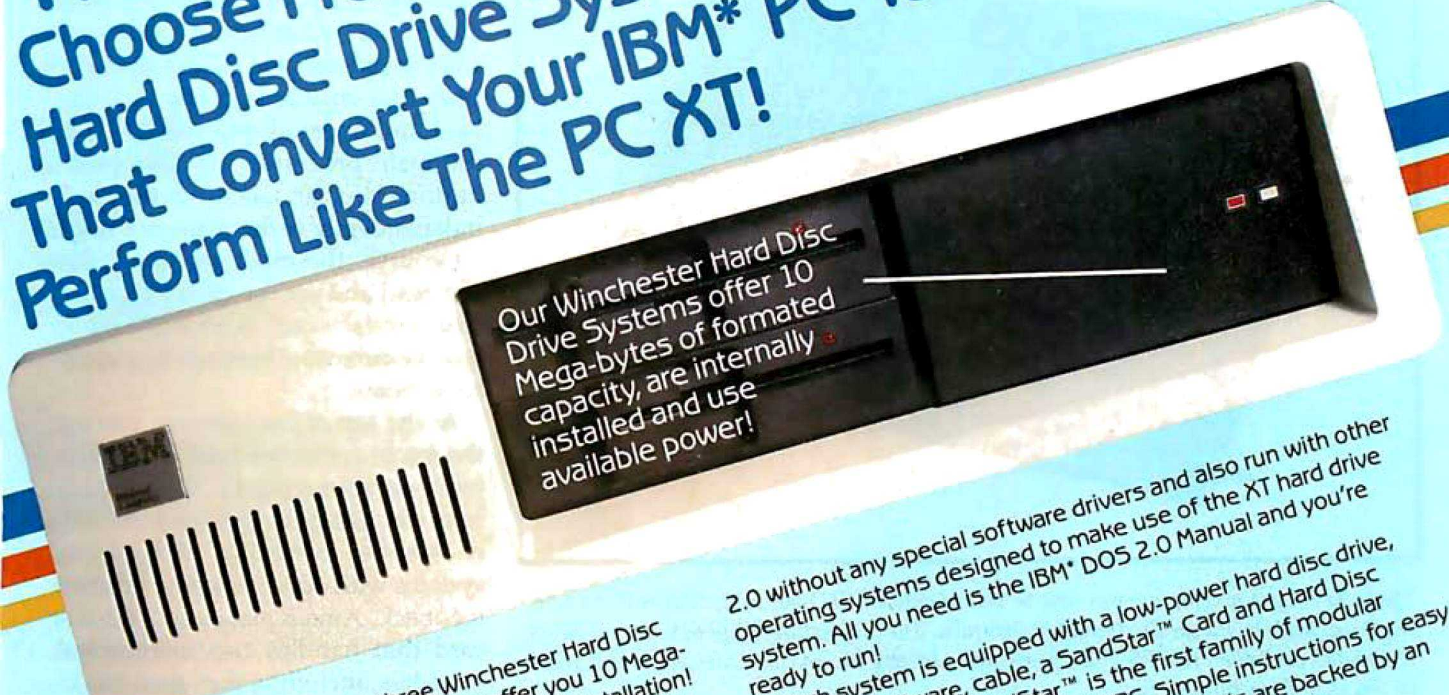

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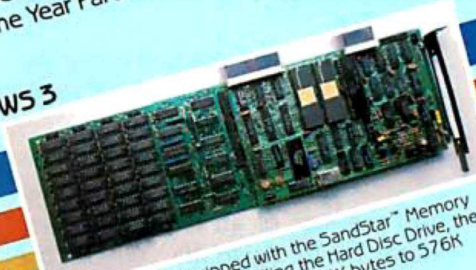

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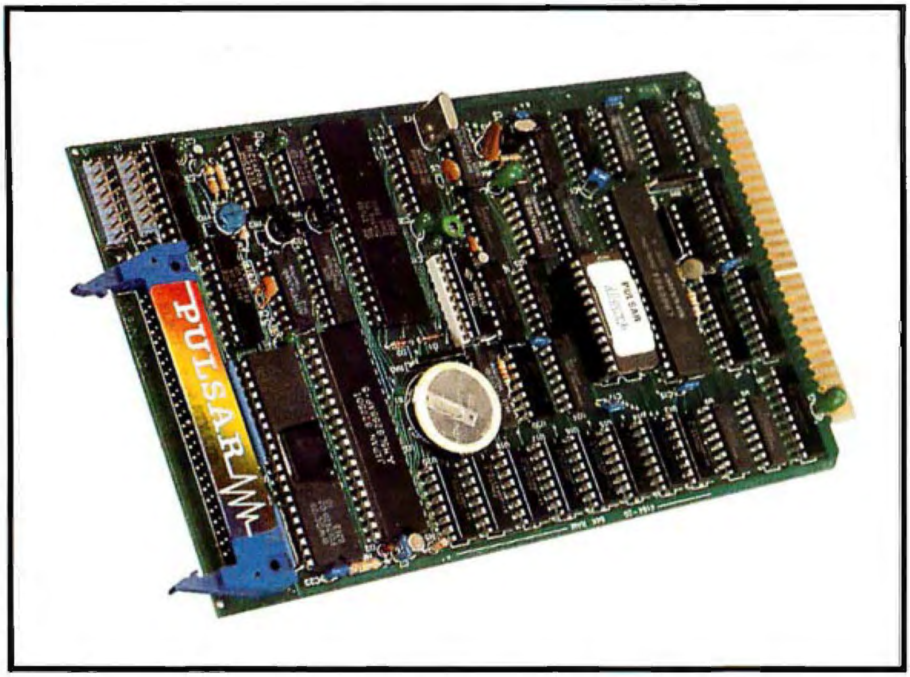

Photo 3: *An entire computer can now be packed onto an STD-bus card. Shown is the Little Big Board made by Pulsar Electronics in Australia. The card features a full 64K bytes of RAM, floppy-disk controller, two RS-232C ports, and a battery-backed clock/calendar. It is available in the U.S. from Infinity Inc.*

I/O, semismart I/O, and very smart controller.

Not so long ago, the first complete computer was put on an S-100 card. A couple of years later, Pulsar Electronics put an entire computer on an STD-bus card, which is about one-third the size of an S-100 card (see photo 3). In Australia, where it's made, the card is affectionately known as the Little Big Board. The Pulsar includes a 4-MHz Z80A, 64K bytes of RAM, 2K bytes of EPROM (boots CP/M 2.2), a floppy-disk controller, two serial ports, and a battery-backed clock/calendar. (In the United States, the Pulsar Single-Board Computer can be purchased from Infinity Inc., either alone or with a card cage, power supply, floppy-disk drive, and other STD-bus cards to form a basic STD-bus system.)

Another single-board STD-bus computer of note is the Transwave K-8073. It uses National Semiconductor's INS8073 processor with on-chip Tiny BASIC. A serial port communicates to a terminal. There are three 8-bit programmable ports (Intel 8255), an ART/RC (asynchronous receiver/transmitter/remote control) master to control up to 128 slave units, a real-time clock/calendar, RAM, EPROM with a monitor, and EPROM for the user's own programs. There are two very unique things about this system. First, it has the most readable manual we've ever seen. Second, once a program is written in Tiny BASIC, you can store it immediately in the onboard EPROM without the fuss of an external EPROM burner.

Straight I/O can be at the TTL level, low-power AC or DC levels, or at high-power AC or DC levels unsafe to bring into the STD-bus card cage. A very flexible and versatile TTL-level I/O card is manufactured by Circuits and Systems. This card has four 8-bit ports that can be configured for either input or output, three 16-bit programmable counters (Intel 8253), a prescaler, and a small wire-wrap area for custom additions to the board. MCPI makes a number of medium-level I/O boards that use optoisolators to protect the STD-bus system. Electrologic makes a 24-channel controller card that connects to Opto 22 control modules mounted externally to the STD-bus card cage to handle higher powers and voltages.

Of the many STD-bus cards made by Enlode, we have used the nicely documented clock/calendar and keypad interface cards. The clock/calendar card, besides being quite smart, has two attractive features: an LED (light-emitting diode) time display that connects to the STD-bus card and operates independently of the main processor, and two pushbuttons you can use to set the clock independently of the main processor. Of course, the main processor also can read and set the clock. The keypad interface card can handle up to four hexadecimal keypads in a priority scheme.

At the top of the interface line are the smart controller cards with their own microprocessors. We already have discussed the intelligent Whedco stepper controller. For control systems with optical encoder position feedback, Amtek makes an STD-bus card that handles two incremental encoders, including the "zero-track" initial positioning type. When the main processor wants to obtain position information, it simply obtains it from a few ports in this smart card. Analog Devices makes what could be the smartest A/D (analog-to-digital) converter in the world. Connect temperature sensors (and others) to the STD-bus card and the microprocessor can read temperatures (or other parameters) from the card's ports. The readings already have been sampled, averaged, corrected for offset, and transformed into engineering units.

In every system it seems there is always something that cannot be bought off the shelf. Even with the world's widest selection of real-time cards to choose from, we could not find a pulse adder or hard-wired limit-switch logic. (Would you totally trust your telescope to a computer?) Rather than make an STD-bus card from scratch, we used a Foundation Module from Contemporary Control Systems. This card contains all the address decoding and buffer logic needed for many applications and has a sizable and conveniently laid out area for wire-wrapping.

The benefits of plug-in cards and standardized buses are lost without a top-quality motherboard and card

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cage. Gold contacts, Faraday shielding, termination, and solid construction are all vital. The control system used on the 16-inch telescope at Fairborn Observatory East resides in a 24-slot Scanbe STD-bus cage, and the separate hardware-development system uses an 8-slot MCPI cage. This system is described in some detail in *Microcomputers in Astronomy* (see reference 2).

Interface Software

The question of software for real-time control systems is not critical if the control system is a simple one. Given a simple situation, straight machine-language programming can be done from the front-panel paddle switches if you have an old-style computer. It is the truly complex situations that make the approaches to software development critical. However, there are few, if any, solid, quantitative comparisons of the efficiencies of different languages and operating systems in the programming of complex control systems. It's just not the sort of thing you program independently in six different languages with 36 different people in order to get valid intercomparisons. Consequently, unsubstantiated opinion is shared by many, including us.

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Assembly language has its advantages. The best use in real-time control is by the contractors that put it in the EPROMs on their smart interface cards. There usually is no need to look at the manufacturer's assembly-language program listings. On rare occasions, a high-level language has to do a task that is simply beyond its speed capabilities. A very small and highly limited assembly-language subroutine is appropriate in this type of case. However, careful design of the system, and an appropriate selection of smart interface cards, often avoids the use of assembly language entirely.

Really good high-level languages are a pleasure to use, and we have gravitated toward the use of two BASICs. On our Z80-based CP/M systems we run Microsoft MBASIC in its interpreted and compiled versions. Programming in the interpreted version is convenient. If greater speed is needed, we use the compiled version. With the proper choice of smart interface cards, an 8-bit microprocessor can loaf along with interpreted MBASIC. Smart cards programmed in assembly language by the card manufacturers do all the hard work.

Our 6809-based systems use Microware's BASIC-09 running in the OS9 operating system. For the true high-level control system aficionado, BASIC-09 is a delight to use. When Joel Boney and Terry Ritter at Motorola started the design of the 6809 microprocessor, they contracted with Ken Kaplan at Microware to develop a language and an operating system that would fully utilize the many unique features of this advanced 8-bit microprocessor. Microware came up with a language that supported structured programming (sort of a cross between BASIC and Pascal), was completely modular (enabling independent programs to work together), and included an interactive compiler with very high level debugging functions. The multitasking OS9 operating system might best be described as Unix on a CP/M budget. The ability to develop software for a complex control system as a number of independent programs is extremely valuable. Programming 6809Es in BASIC-09 is very easy.

Summary

In closing, we would like to summarize our advice. First, don't consider the controlled system immune to change. It may be easier to make it more conducive to microcomputer control than go through interface or software contortions. Second, make a careful trade-off between interface hardware and the software you will have to write. Make it easy on yourself and put some burden on the interface hardware—that's why it was developed. Third, if you can use a single-board computer in your application, do so. Otherwise, use a bus with a good selection of off-the-shelf interface cards. Fourth, do most of your programming in a language you feel comfortable with. BASIC is not a bad choice. Finally, don't be bashful. Go ahead and try some real-time control with your system. There is a special fascination in things that move by themselves under the direction of a microcomputer.

Russell M. Genet, Louis J. Boyd, and Douglass J. Sauer are the technical staff at Fairborn Observatory. Genet and Sauer work at the Observatory's eastern branch (1247 Folk Rd., Fairborn, OH 45324). Boyd works at the Observatory's western branch (629 North 30th St., Phoenix, AZ 85008). All three are electrical engineers and share the hobbies of astronomy and computers. Among them they have three STD-bus computers and four 6809-based systems.

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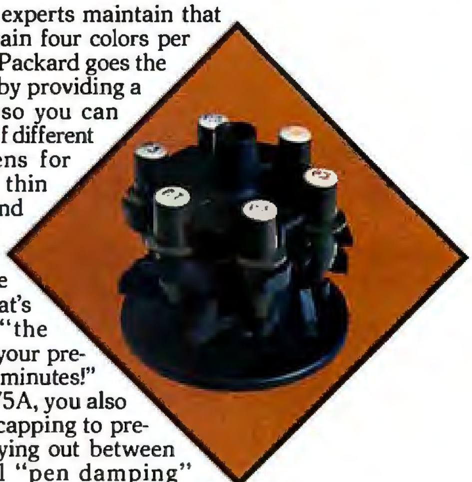

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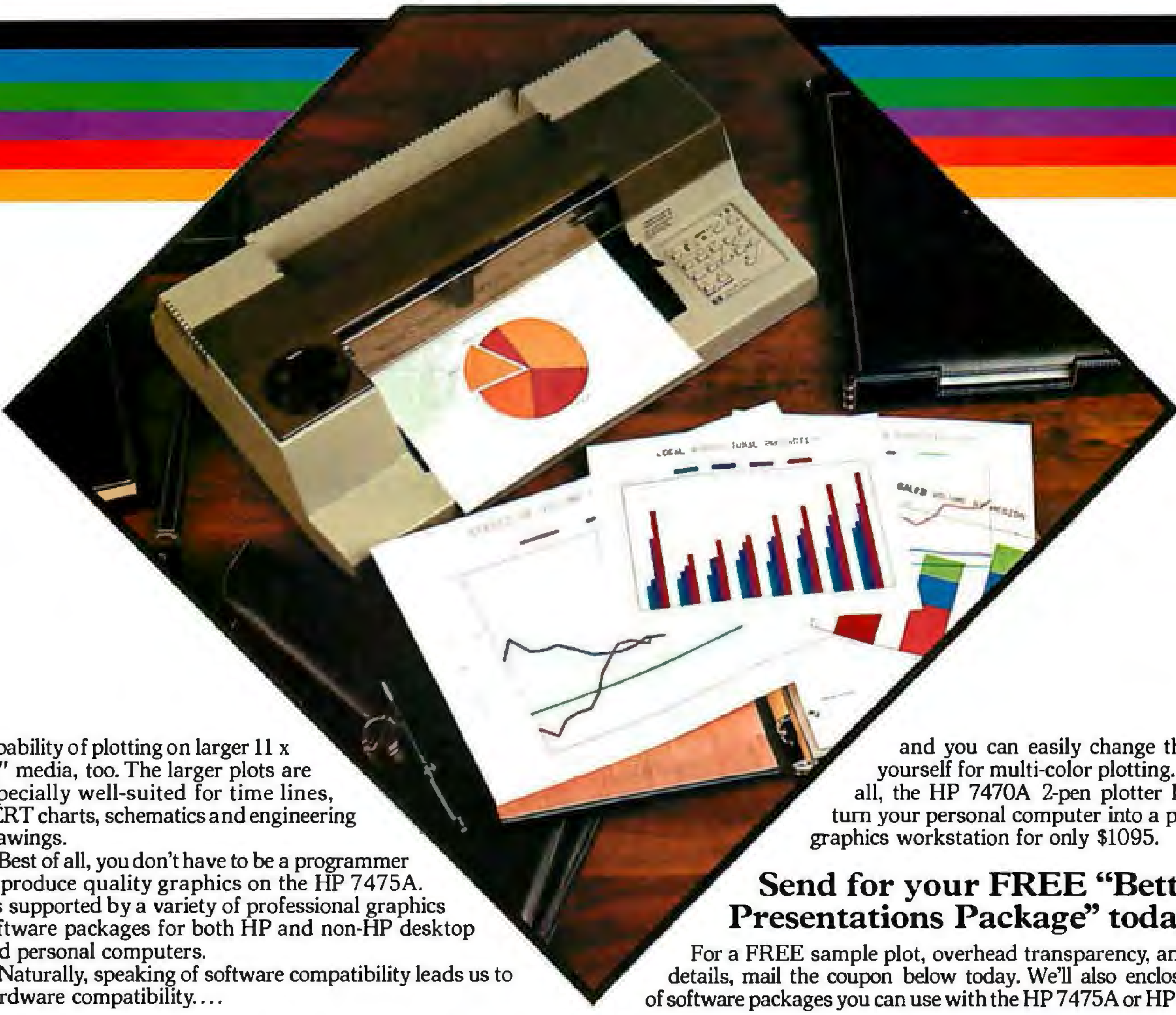

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Putting the Apple II Work

Part 1: The Hardware

A high-speed system for the acquisition and analysis of data

Richard C. Hallgren
Michigan State University

The world we live in is anything but static. We are constantly exposed to a changing environment that our central nervous system samples, analyzes, and, when necessary, responds to. In many ways, computer systems are a lot like the human body, which is equipped with a number of specialized sensors that convert complex, time-dependent information into a form that can be sampled by the nervous system. The nervous system processes the incoming information and makes decisions that cause the system to respond appropriately. Computers, when equipped with specialized sensors, also can sample the surrounding environment, process this incoming information according to some predetermined algorithm, and effect an appropriate response.

Many commercially available transducers can be used to convert physical-energy variations into time-varying electrical voltages. For example, thermistors can be used to measure temperature, dimensional changes can be measured by resistive strain gauges, and PIN diodes can be used to measure changes in light intensity. If a physical parameter changes very slowly and you have an abundance of time, you can use a digital voltmeter, a digital clock, and a pencil to record data and enter it into the computer by hand at some later time. However, if you desire an automated system or if the transducer output voltage changes at a rate that makes manual sampling impractical, you will need a computer-based data-collection scheme that will reduce the amount of operator interaction and still allow the collection of large amounts of data.

In part 1 of this article, I'll introduce the hardware required for such a system, discuss its operation and construction, and go through preliminary checkout and testing. In part 2, I'll provide the Applesoft and machine-language listings and discuss their development and use.

While most computers are quite proficient when it comes to handling binary (on/off) voltages, they usually are not capable of directly handling the analog voltages from the output of most transducers. Placing an analog-to-digital (A/D) converter between a transducer and the computer enables the computer to monitor the changing physical parameter as well as to automate the sampling process.

An Apple II was selected several years ago for use in our laboratory. While many new computers have since been introduced into the marketplace, the Apple II continues to be my first choice for the following reasons:

1. The Apple II features eight built-in connectors that make adding external interface circuitry a relatively easy task.
2. An abundance of commercial software is available.
3. The multicolor, high-resolution graphics software enables several channels of data to be displayed simultaneously.
4. The logical structure of the 6502 and the existence of a miniassembler within the Apple firmware make machine-language programming relatively easy.
5. It is extremely reliable. When it has needed repair, service was easy to find and the repairs quickly completed.

Design Criteria

I designed the circuitry discussed in this article to perform the specific task of digitizing the complex voltage waveforms produced by a muscle being exercised. I needed to simultaneously sample three channels of this electromyographic (EMG) information so the data would be synchronized at specific points in time. Because I was preprocessing the EMG by taking the absolute value and then passing those signals through a low-pass filter, I knew that the input voltage to the A/D converter would always be positive, that it would never exceed a maximum value of 5 volts (V), and that the highest frequency component would be no greater than 100 Hz. With this information in mind, I determined the design specifications for the A/D converter.

Essentially, three factors create major limitations to the accuracy and usefulness of data collected through an A/D converter: loss of significance, resolution, and sampling rate.

Loss of significance is what occurs when the maximum magnitude of the input signal is much less than the A/D converter's maximum input range. As an example, suppose that you are using an 8-bit A/D converter that has a maximum input of 10 V. The input range of 10 V is then spanned by the 256 (2^8) possible voltage levels that the A/D converter can quantize. When the input voltage is equal to 10 V, the entire number of possible voltage levels is used. The signal-to-noise ratio then can be expressed as 20 times the logarithm of the ratio of the input voltage to the smallest quantized voltage level, or 20 $\log_{10}$ (255/1) = 48 decibels (dB). Suppose the input voltage had been only 2 V. The A/D converter would have then used only 50 of the 255 possible voltage levels, reducing the signal-to-noise ratio to 20 $\log_{10}$ (50/1) = 34 dB. Consequently, it is important to match the maximum input voltage to the maximum input range of the A/D converter whenever possible.

Resolution is related to the ability to distinguish between two voltage levels that are nearly equal. The smallest magnitude difference that can be detected defines the resolution of the system. For an A/D converter that represents a 10-V analog input voltage by an 8-bit binary number, resolution is equal to 10/256 = 0.039 V. Under ideal conditions, the system should be able to distinguish between two signals with a voltage difference of 0.039 V.

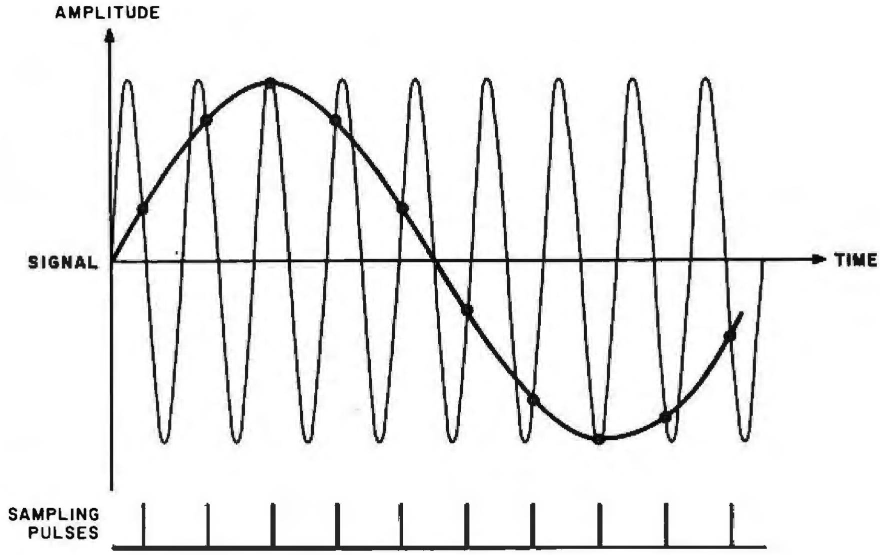

Figure 1: *An example of aliasing caused by a sampling rate that's too low.*

The sampling rate determines the computer's ability to detect time-dependent changes in the input voltage. As an example, consider an input signal that is changing at a rate equal to 50 V/second. Suppose that you wanted to resolve the input signal with a 3 percent accuracy (within ±0.3 V for an input equal to 10 V) at any point in time. An input voltage that is changing at a rate equal to 50 V/second changes by 0.3 V in 6 milliseconds (ms). Consequently, to achieve 3 percent accuracy, you must sample the input signal at least once every 6 ms.

Loss of significance, resolution, and sampling rate are three factors involved in data collection through an A/D converter.

If you don't have an intuitive feel for the accuracy you need, a good rule of thumb is to set the sampling rate to twice the maximum frequency component of the input signal. When you sample too slowly, you can have problems with *aliasing*, which results when a high-frequency signal impersonates a low-frequency signal (see figure 1). For applications in which you will be sampling at rates that are less than twice the highest frequency component, you must insert a low-pass filter at the input of the A/D converter to limit the frequency content and to ensure faithful reproduction of the input signal. When you sample too quickly, you will quickly expend the available memory in the computer. However, it is generally better to have too much data than not enough.

System Hardware

The AD7570 from Analog Devices Inc. (Two Technology Way, Norwood, MA 02062, (617) 329-4700) is a successive-approximation-type A/D converter that requires only an external reference and a comparator to provide either an 8- or 10-bit output representation of the input signal. A three-state output register is used to buffer the digital output signals, enabling several AD7570s to be connected in parallel to a single data bus. This feature permits you to use a separate A/D converter for each input channel, thus providing increased system throughput rate.

The AD7570 uses a conversion scheme known as successive approximation to achieve the high resolution and conversion speed necessary for

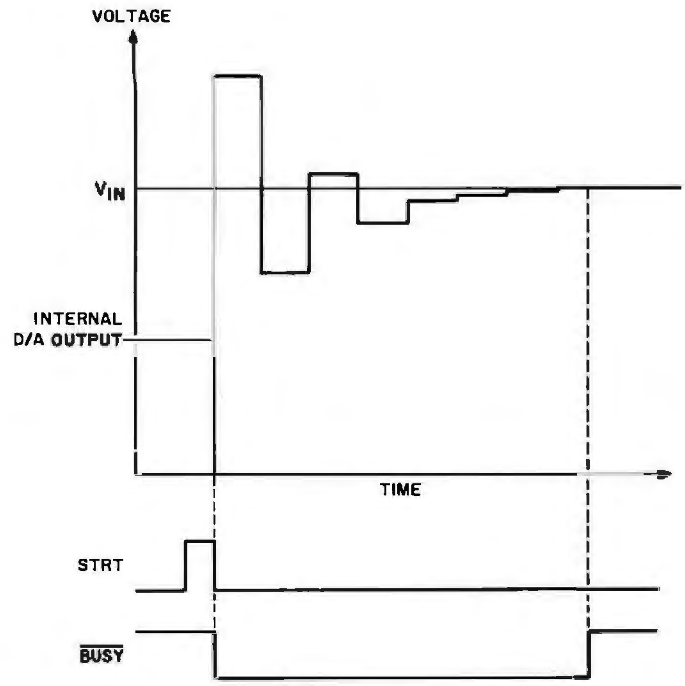

Figure 2: *Analog-to-digital (A/D) conversion example using the successive-approximation technique. The A/D converter output makes several steps before matching the input voltage.*

some computer applications. Successive approximation involves comparing the unknown input voltage with a preset series of voltage increments that are binary fractions of the maximum input range that the A/D converter can handle.

Initialization of the conversion sequence begins when the convert start (STRT) input goes to a logical 1 (see figure 2). At this time, the most significant bit (MSB) of the data latch is set to a logical 1, and the remaining bits of the data latch are set to a logical 0. When the STRT line is returned to a logical 0, the actual conversion process begins. The output of the internal digital-to-analog (D/A) converter is sequenced bit by bit from the MSB to the least significant bit (LSB).

The external comparator determines whether the addition of each successively weighted bit creates a voltage that is greater than or less than the input voltage. When the voltage is greater, the bit is turned off (set to a logical 0); when the voltage is less, the bit is left on (set to a logical 1). After this comparison is made between all bit combinations, the conversion is complete and the internal successive-approximation register contains the binary code that represents the converted input signal. Thus, for a converter circuit that can measure an input voltage varying between 0 and 10 V (10 V is full scale), the comparisons would be made between voltage levels that varied in 0.039-V increments (10 V divided by 256 discrete levels).

When an unknown input voltage is to be converted, first, the MSB of the internal D/A converter's output (one-half full scale) is turned on, comparing the input voltage to 5 V. If the input voltage is less than 5 V, the MSB is turned off, the next bit (one-fourth full scale) is turned on, and the input voltage is compared to 2.5 V. If the unknown input voltage is greater than 2.5 V, the second bit is left on, the next bit (one-eighth full scale) is turned on, and the input voltage is compared to 3.75 V. (2.5 + 1.25). If the unknown input voltage is less than 3.75 V, the third bit is turned off, the next bit (one-sixteenth full scale) is turned on, and the input is compared to 3.125 V (2.5 + 0.625). This process continues in order of descending bit weight until all bits have been tried. The conversion process is thus completed, and the 8-bit binary number representing the unknown input voltage is ready to be read by the computer.

I have divided the circuitry associated with the A/D converter into two classifications: circuitry that deals primarily with analog signals and circuitry that deals primarily with digital signals. Figure 3 shows the circuitry dealing with analog signals. IC1 is a three-terminal voltage regulator that provides −5 V to the reference voltage terminal (pin 2) of the AD7570s. I used a 5-V reference because the signals that I am digitizing do not exceed 5 V. The AD7570 is capable of accepting voltages from 0 to +10 V at the input terminal. Because the three input sections are identical to each other, I will describe only the circuitry associated with Input 1. The A/D converter (IC2a) works in conjunction with the comparator (IC5) to determine the binary representation of the input signal. As the internal successive-approximation register changes the weighted bit pattern, IC5 compares the output of the internal D/A converter with the input signal. The results of the comparison are fed back to pin 7 of the AD7570, and the successive-approximation register makes appropriate adjustments to the weighted bit pattern. The 1k-ohm resistor is connected across the comparator input terminals to reduce the settling time of the comparator, which ultimately reduces the conversion time.

Figure 4 shows the digital circuitry. As in the description of the analog circuitry, only one input channel will be discussed because the other two channels are identical. The AD7570 has a provision for what is called a short-cycle conversion. This is accomplished by connecting the $\overline{SC8}$ (pin 26) control line to a logical 0, forcing the converter to stop the conversion cycle after 8 bits, and reducing the conversion by two clock cycles. Even more important than achieving the time savings of two clock cycles is the time saved by having to read in only 8 data bits per input channel. For my applications, the increase in sampling rate that could be achieved was considered to be worth the resolution that was lost.

Operating under the short-cycle format, the conversion process still starts with the MSB and works down

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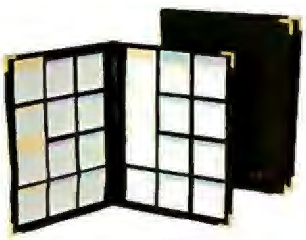

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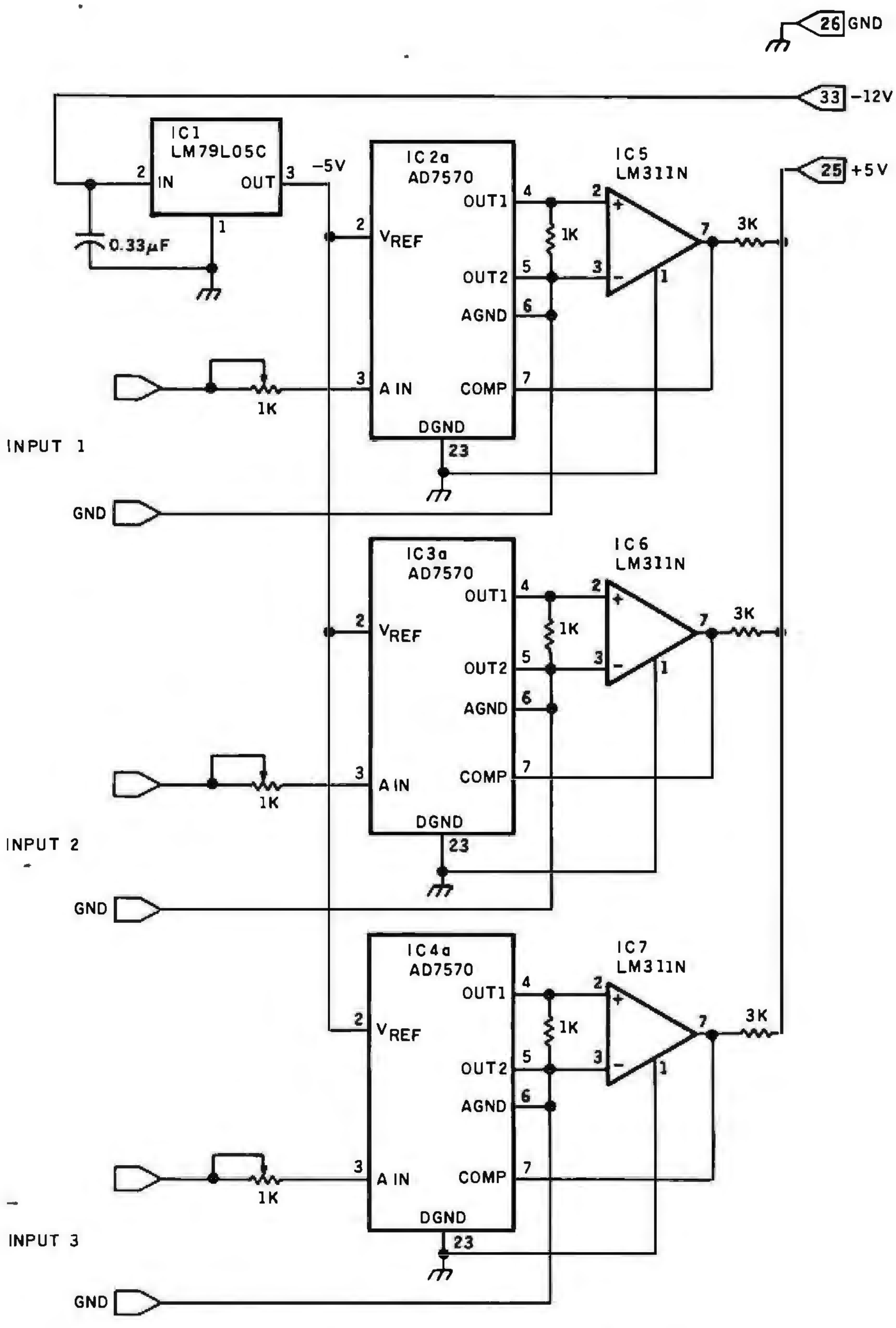

IC	+5 V	+12 V	−12 V	Ground
1	—	—	2	1
2, 3, 4	22	1	—	6, 23
5, 6, 7	—	8	4	—

Figure 3: *A/D converter analog input circuitry.*

to DB2. The 8 bits of digitized data are then contained on data lines DB2 through DB9. The high-byte enable (HBEN) control line is a three-state enable for DB9 (MSB) and DB8. When HBEN is a logical 1, digital data from the internal latches appears on the data lines. The low-byte enable (LBEN) control line is a three-state enable for DB0 (LSB) through DB7. When LBEN is a logical 1, digital data from the internal latches appears on the data lines. Because the short-cycle mode uses only data lines DB2 through DB9, HBEN and LBEN are connected together so that a logical 1 causes the digital data representing the converted input signal to appear on the data lines.

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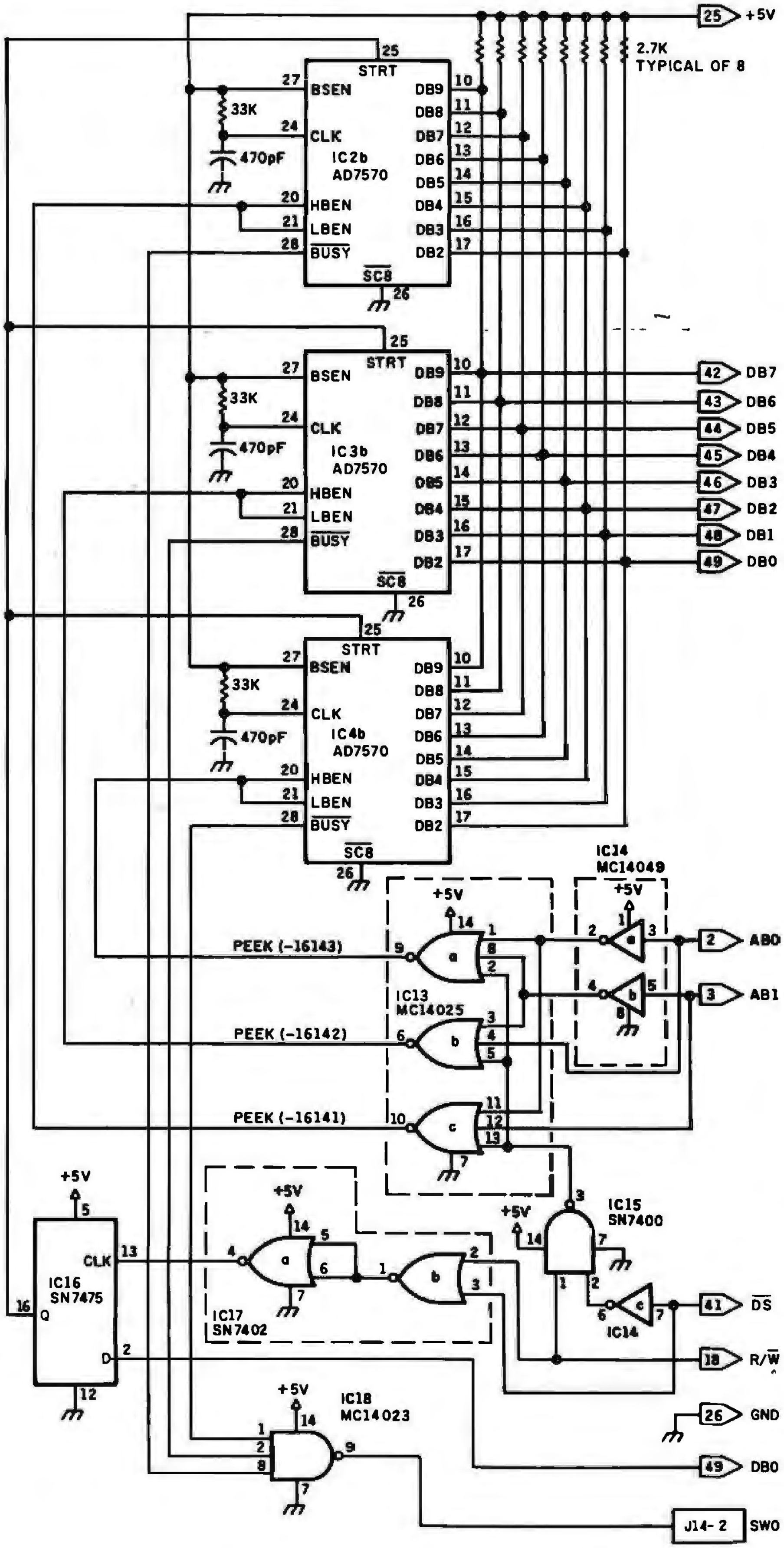

Figure 4: *A/D converter digital circuitry.*

line (pin 27) is used to determine if the converter status line ($\overline{BUSY}$) is enabled or if it is floating. In this application, I connected the BSEN line to a logical 1. Thus, the $\overline{BUSY}$ line always reflects the status of the converter. During the time that the conversion is being performed, the $\overline{BUSY}$ line is set to a logical 0. Upon completion of the conversion, $\overline{BUSY}$ is set to a logical 1.

The 33k-ohm resistor and the 470-picofarad (pF) capacitor are used to determine the internal clock frequency. With these values, the clock frequency is approximately 100 kHz. Clock activity begins upon receipt of a conversion start pulse and ceases upon completion of the conversion.

The remaining circuitry in figure 4 shows the control logic necessary to initiate the conversion cycles for all three converters, to sense when the conversion cycles have been completed, and to coordinate the transfer of data into the computer. The circuit is designed so that the peripheral card resides in I/O (input/output) slot 7 on the Apple II motherboard. The device-select signal goes to a logical 0 whenever memory locations (hexadecimal) C0F0 through C0FF are addressed. [**Editor's Note:** *All addresses and number values are hexadecimal unless otherwise specified.*] The least significant 2 bits of the address are decoded by IC13 and are used to transfer data from one of the three converters by enabling the three-state buffer of the appropriate converter. A conversion cycle is initiated by performing an LDA #01, STA C0F0 followed by an LDA #00, STA C0F0. This causes the output of the D-type flip-flop (IC16) to go from logical 0 to logical 1 and back to logical 0. This pulse is connected to each of the AD7570s, causing the three unknown input signals to be converted simultaneously. IC18 is used to indicate to the Apple II that all three converters have completed their conversion cycles. The output of IC18 is connected to one of the inputs on the game connector. Performing an LDA C061 loads the status of the game input into the 6502's accumulator; rotating the accumulator to the left and testing the carry bit enables the

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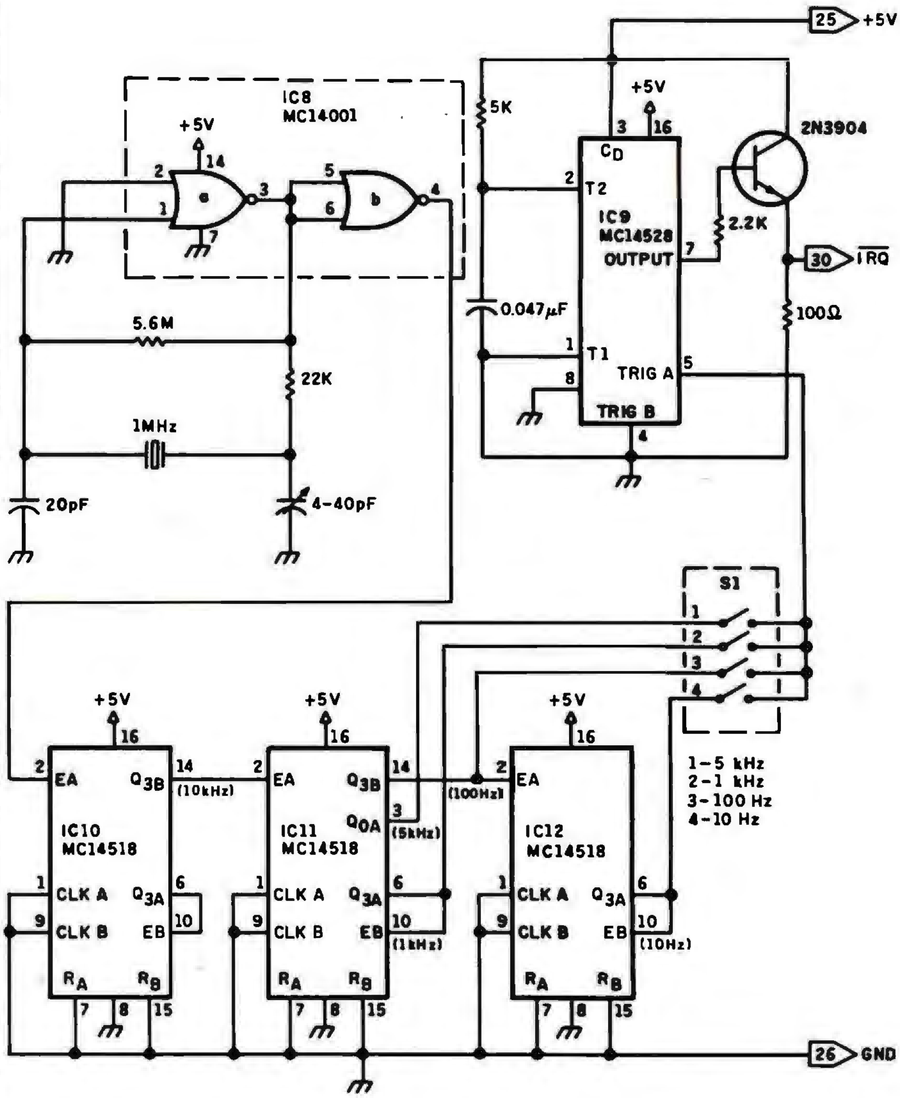

Figure 5: *Crystal-controlled time base used in the A/D converter.*

program to determine whether the conversions are complete.

It is desirable to take periodic data samples and to know the relationship between the magnitude of the data and time. This enables displaying the data as a function of time and permits the analysis of the data with respect to time. Some analysis techniques (such as fast Fourier analysis) require the data to be sampled periodically and the time between samples known. I used the interrupt-request line ($\overline{IRQ}$) going to the 6502 microprocessor to control when a sample was to be taken. The $\overline{IRQ}$ control line is called a maskable interrupt because the system will jump to a given memory location if an interrupt request is received and if the interrupt system has been enabled. The CLI (clear interrupt-disable bit) command is used to arm the 6502 so that it will respond to the next interrupt request it receives.

Once a request is received, the 6502 first executes an indirect jump using the address contained in memory locations FFFE (LSBs) and FFFF (MSBs). The 6502 then executes a short subroutine that serves to handle the interrupt request. Ultimately, the 6502 is forced to jump to the memory location contained in memory locations 3FE (LSBs) and 3FF (MSBs). The Hello program, which is executed when the computer is first turned on, uses POKEs to place the desired interrupt entry point into addresses 3FE and 3FF. Hello also disables the interrupt system so that an interrupt will not be prematurely executed. Once execution of the interrupt routine has been

Listing 1: *A/D converter system initialization routine.*

```
10 REM HELLO
20 HOME: REM CLEAR SCREEN
30 PRINT "*****************************************"
32 PRINT "*             A/D CONVERTER             *"
34 PRINT "*****************************************"
50 REM DEFINE INTERRUPT JUMP ADDRESS
52 POKE 1022,64:POKE 1023,144
54 REM INTERRUPT DISABLE SUBROUTINE
56 POKE 1016,72:POKE 1017,8:POKE 1018,120:POKE 1019,40:
   POKE 1020,104:POKE 1021,96
58 CALL 1016: REM EXECUTE SUBROUTINE TO DISABLE INTERRUPT
   REQUEST LINE
80 D$="": REM DOS CONTROL CHARACTER
82 PRINT D$;"RUN TEST,D1": REM LOAD AND EXECUTE MAIN APPLESOFT
   PROGRAM
99 END
```

performed, an RTI (return from interrupt) command is executed to force the processor to return to the instruction that was being executed when the interrupt request was first received.

Figure 5 shows the circuit that controls when a sample is taken. IC8 and its associated resistors, capacitors, and 1-MHz crystal form a stable, accurate, square-wave oscillator time base. IC10, IC11, and IC12 divide the output frequency of the oscillator so that several different sampling frequencies can be obtained. IC9 is a monostable multivibrator that provides a fixed width pulse that is synchronized to the sampling frequency. The 2N3904 transistor is used to provide a low-impedance output to the $\overline{IRQ}$ going to the 6502. I designed the clock circuitry so that sampling rates of 5 kHz, 1 kHz, 100 Hz, and 10 Hz can be obtained by closing the appropriate contacts on S1.

Construction Hints

If you have built electronic circuits before, either from scratch or from a commercially available kit, you should consider building the high-speed A/D converter. If you are careful, the chances of damaging your Apple are low and the chances of the circuit working are high. I will try to increase your probability of success by providing some advice and some specific points to check as you finish building each section.

I recommend that you buy the hobby/prototype board for the Apple II and use wire-wrap construction. This type of construction goes together fast and lends itself to easy correction of wiring errors. The cost of the wire-wrapping tools is a little high, but it is doubtful that you will ever wear them out. You can order the A/D converter ICs directly from the manufacturer; the rest of the components can be purchased from Jameco Electronics (1355 Shoreway Rd., Belmont, CA 94002, (415) 592-8097).

Start by building the crystal-controlled time-base oscillator shown in figure 5. Beg or borrow an oscilloscope and perform the following tests:

1. Initially, do not connect the $\overline{IRQ}$ line from the 2N3904 transistor to pin 30 on the hobby/prototype board.
2. With the computer turned off, plug the hobby/prototype board into peripheral I/O slot 7.
3. Turn the computer on. It should function normally. If the computer does not function normally, turn it off and pull out the hobby/prototype board. Turn the computer back on to see if normal operation has been restored. If so, you have made an error in wiring or you probably have inserted one of the ICs into a socket backward.
4. Once you get the Apple to work with the board plugged in, connect the oscilloscope to pin 2 of IC10, where you should see a distorted square wave having a frequency approximately equal to 1 MHz. Adjust the 4-40-pF trimmer capacitor until this frequency is equal to 1 MHz.
5. Measure the pulse width of the

$\overline{\text{IRQ}}$ output at the 2N3904 transistor. It should be approximately equal to 0.1 ms. If there is no output pulse at this point, work your way back toward pin 2 of IC10 until you find the square wave again. Once you find the square wave, you can be pretty sure that you have made a wiring error somewhere between that point and the $\overline{\text{IRQ}}$ line.

6. The frequency of the $\overline{\text{IRQ}}$ pulse train should change as you open and close the various switches on S1. If it does not, you should check the wiring at this point in the circuit.
7. Initialize a new disk using the Hello routine shown in listing 1. Connect the $\overline{\text{IRQ}}$ line to pin 30 on the hobby/prototype board and turn the computer on. If it does not function normally, you probably have made an error in entering Hello.

Next, wire the logic circuitry shown in figure 4 and perform the following measurements:

1. Execute the following BASIC statements; you should see the Start Conversion pulse (pin 5 of IC16) periodically go from 0 to +5 V.

```
100 POKE -16143,0
110 FOR I=0 TO 100:NEXT I
120 POKE -16143,1
130 FOR I=0 TO 100:NEXT I
140 GOTO 100
```

2. Execute the following BASIC statements; you should see the Data Strobe pulse for Input 1 (pin 9 of IC13) periodically go from 0 to +5 V.

```
100 X=PEEK(-16143)
110 FOR I=0 TO 100:NEXT I
120 GOTO 100
```

3. Execute the following BASIC statements; you should see the Data Strobe pulse for Input 2 (pin 6 of IC13) periodically go from 0 to +5 V.

```
100 X=PEEK(-16142)
110 FOR I=0 TO 100:NEXT I
120 GOTO 100
```

4. Execute the following BASIC statements; you should see the Data Strobe pulse for Input 3 (pin 10 of IC13) periodically go from 0 to +5 V.

```
100 X=PEEK(-16141)
110 FOR I=0 TO 100:NEXT I
120 GOTO 100
```

If you have made it this far, congratulations. The next phase is the most difficult to test, so be especially careful when you wire it up. For now, you should wire up the AD7570 associated with Input 1. Keep the leads between IC2 and IC5 short to minimize the tendency for the circuit to oscillate. Once you have finished building the circuit, perform the following tests to make sure it is working correctly:

1. The voltage at pin 2 of IC2 should be equal to −5 V.
2. Execute the following BASIC statements; you should see the $\overline{\text{BUSY}}$ line periodically go from 0 to +5 V.

```
100 POKE -16143,0
110 POKE -16143,1
120 POKE -16143,0
130 FOR I=0 TO 100:NEXT I
140 GOTO 100
```

If your circuit passed all these tests, there is a high probability that it is wired correctly. You will now need to test your hardware with the software routines I'll provide next month in part 2.■

Acknowledgment

This project was supported by the Human Capability Corporation of Southfield, Michigan.

Richard C. Hallgren is an associate professor in the Department of Biomechanics, Michigan State University, East Lansing, MI 48824. He works on applications of microprocessor-based systems to scientific research.


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COMPATIBILITY
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STANDARD
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COMPATIBILITY
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MATURE
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RELIABLE
DOCUMENTATION
EASY TO USE
DEVELOPMENT
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BUSINESS
EXPANDABILITY
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DOCUMENTATION
DOCUMENTATION
EVOLUTIONARY
PRODUCTIVITY
FLEXIBILITY
FAMILIARITY
EASY TO LEARN
MULTI-TASKING
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SUPPORT
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SUPPORT
PRODUCTIVITY
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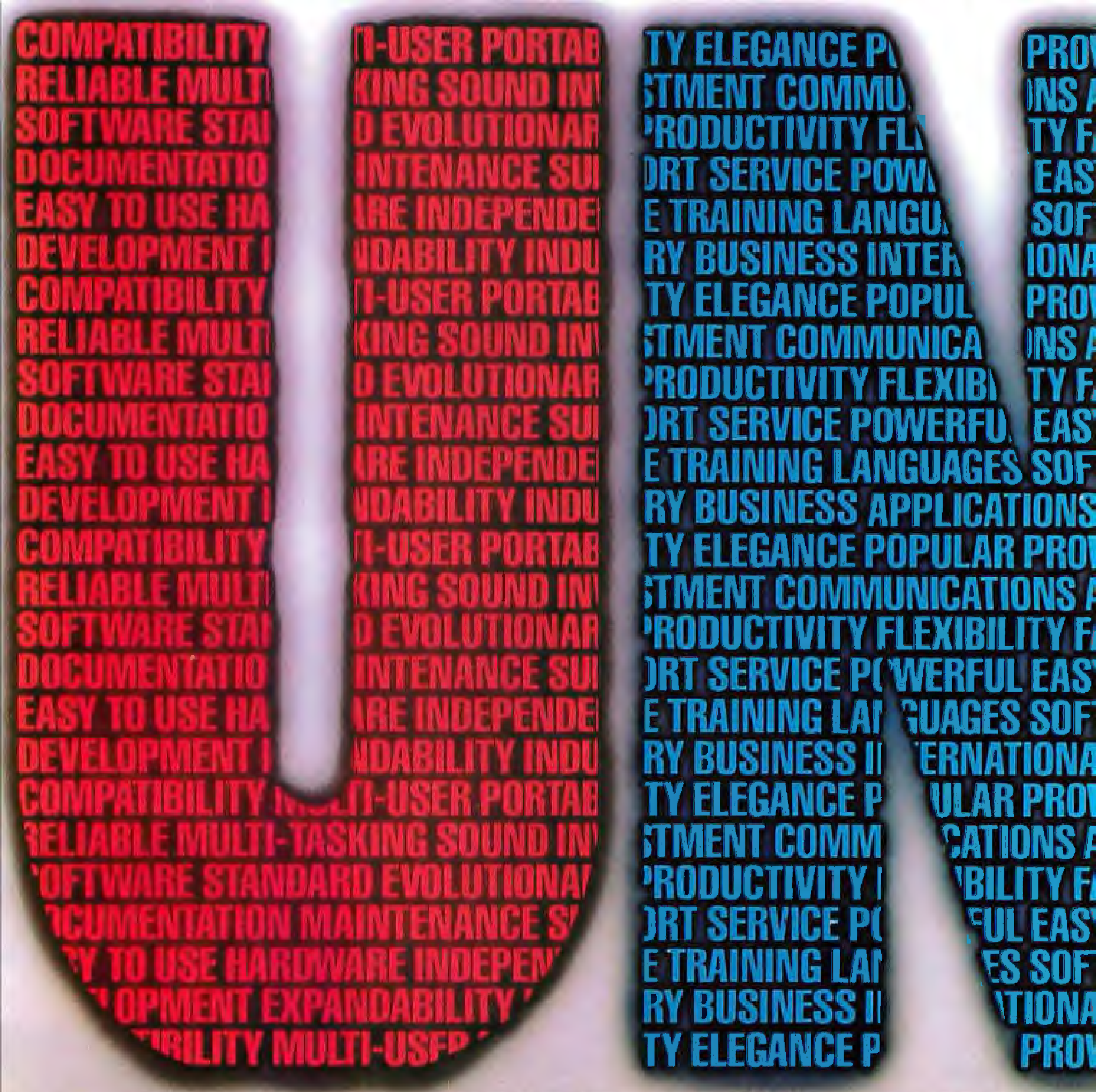

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Reviewer's Notebook

Rich Malloy
BYTE Senior Technical Editor

The Panasonic Sr. Partner

As everyone knows, the success of the IBM PC has set off an avalanche of PC clones, not only in the U.S., but also in the Far East. A prototype of one of these arrived here recently from Japan. And judging by this prototype, I am tempted to say that this one looks like the best of all. This new transportable is called the Sr. Partner (I assume that they mean *Senior* Partner, not *Señor* Partner) and it has some incredible capabilities at a very reasonable price.

The Sr. Partner is a little smaller than the standard sewing-machine-type transportable computer such as the Compaq. It features a 9-inch green-phosphor display, two half-height 5¼-inch drives (320K bytes each), a good supply of memory (256K bytes), *and* a thermal printer. And then there's the software: Wordstar, Visicalc, PFS:File, PFS:Report, PFS:Graph, GW-BASIC, and MS-DOS version 2.0. This all costs $2495.

As if that is not enough, the Sr. Partner is also one of the most compatible PC clones I've seen. Even PC-TALK, the popular low-priced BASIC communications program runs on it. It seems to rank right up there with the Compaq. Also, the Sr. Partner's graphics adapter actually seems to be better than the IBM PC's. It doesn't flicker during scrolling, and objects that are meant to be colored on a color display come out as true grays on the monochrome monitor, not as hatched areas.

Not everything is perfect, however. Although the display does not flicker during scrolling, the scrolling does seem to be a little slower on this display. Also, the fan on this machine sounds like a small vacuum cleaner.

I'm not sure exactly how Panasonic will be selling this machine. The Japanese seem to have trouble marketing their computers in the U.S. But if you see one of these at your local computer store, I suggest taking a good look at it.

The ACT Apricot

With the arrival of the Macintosh and the HP 150, the new small 3½-inch disks are getting very popular. Yet another machine to use these disks is the Apricot, new from the ACT Corporation, which sells the Victor 9000 (né Sirius) in Europe. The Apricot features a 9-inch display, two 3½-inch disk drives, and a keyboard that has a small 2-line liquid-crystal display. It is also a semitransportable, which means it doesn't look like a sewing machine (like all the other transportables), but it's small and you can take it home for the night without too much difficulty. The computer sells for $3100 and comes with a modest selection of software.

Apricot's designers have taken advantage of some of the capabilities of MS-DOS version 2.0 to produce an elaborate menu-based operating system. This system is interesting, but I'm a bit too jaded to appreciate it. Perhaps I've spent too much time on CP/M.

The really interesting thing about the Apricot is the LCD on its keyboard. Sometimes it functions as a clock/calendar and at other times it is used to label the six function keys on the keyboard. And, if you press the Calc button on the keyboard, the LCD becomes a regular calculator. This extra display is a nice idea that other manufacturers should study.

The Smart Cable

An interesting product arrived here from IQ Technologies in Bellevue, Washington, called the Smart Cable (SC817). This enhanced connecting cable promises to connect almost any computer's serial port to almost any serial peripheral for $90. All you have to do is make sure the transmission rates, word lengths, and stop bits match up on both machines.

Such a product would be ideal for a place like BYTE, where we are always trying to link up a new computer with a new printer. Unfortunately, the Smart Cable is not quite as smart as I would have hoped; it is not a simple "connect it and forget it" device. You have to flip a few switches on the cable connector until transmission is successful. And it doesn't work with every computer and every printer. For example, we had trouble connecting a NEC APC computer with a NEC Spinwriter. But it is better than resorting to the breakout box and trying to match the proper signal lines. And it is quicker than trying to get some overworked distributor to send the right code.

This Month

The most newsworthy review in this issue is on Coleco's Adam (see page 206). Our reviewer claims that the machine that sounded too good to be true, is.

The Rainbow 100 from DEC also finally gets a chance to be reviewed (see page 170). Note, however, that our reviewer never did get a copy of MS-DOS or a CP/M-86 format program to work with in time for the review. Such products do exist, and they work fairly well. DEC does seem to produce good products, but they take quite a bit of time.

As for software, we have a review of the Peachtext 5000 package for the several leading MS-DOS machines (see page 186). Also, on page 224 we review Micro-Logic, a simulation program for logic circuits.

And last, but by no means least, we have an immense survey of 24 statistical packages for various microcomputers (see page 234). This survey is so comprehensive that you might need one of these packages just to compare them all.■

Rich Malloy is BYTE's product-review editor.

Hardware Review

The Rainbow 100

It runs CP/M-80, CP/M-86, and MS-DOS, but only on Rainbow-format disks

David B. Suits
Rochester Institute of Technology

The Rainbow 100 microcomputer was Digital Equipment Corporation's first stab at the microcomputer market. When introduced last year, only a handful of programs were available for it. Times have changed, though, and the Rainbow is worth looking at again.

The Rainbow, shown in photo 1, has two microprocessors instead of the usual one: an 8-bit Z80A and a 16-bit 8088. It has a large keyboard, an excellent display (with a color-graphics option), serial ports for a printer and modem, and a 400K-byte dual-disk drive. It comes with CP/M-86/80, which can run either 8- or 16-bit CP/M programs. MS-DOS is available as an option.

The Display

The standard Rainbow comes with a 12-inch (diagonal) black-and-white monitor that is compatible with the DEC VT102 terminal. It is packaged in a tapered plastic case that is small enough and light enough (about 14 pounds) to be moved easily on your desk. The monitor has an adjustable rear leg so that you can tilt it back to the viewing angle you prefer. Brightness and contrast controls are at the rear of the monitor, which is not a particularly accessible location. But since they will probably not be used often, their placement should not be a problem.

Each character on the display is formed from an 8- by 9-pixel array (which includes 2 pixels for descenders) inside a 10 by 10 matrix. The characters may be displayed normally, in reverse video, highlighted, blinking, and underlined. Double-width and double-height characters are also available, but only on a line-by-line basis. Photo 2 shows how Rainbow characters look without enhancements.

Photo 1: *The Rainbow 100 computer.*

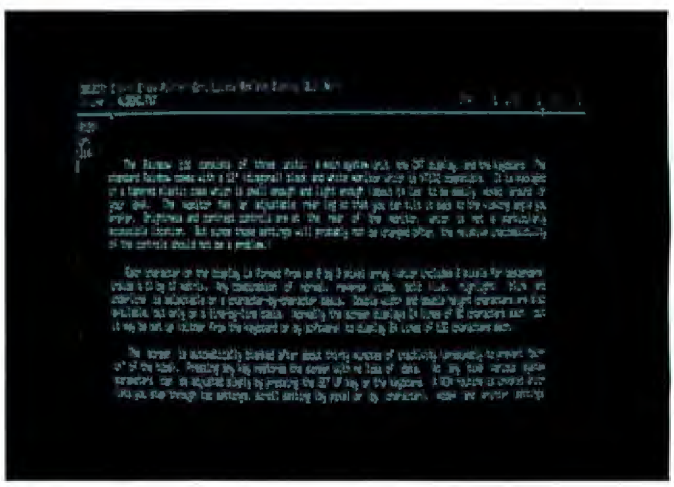

Photo 2: *A sample display on the Rainbow 100.*

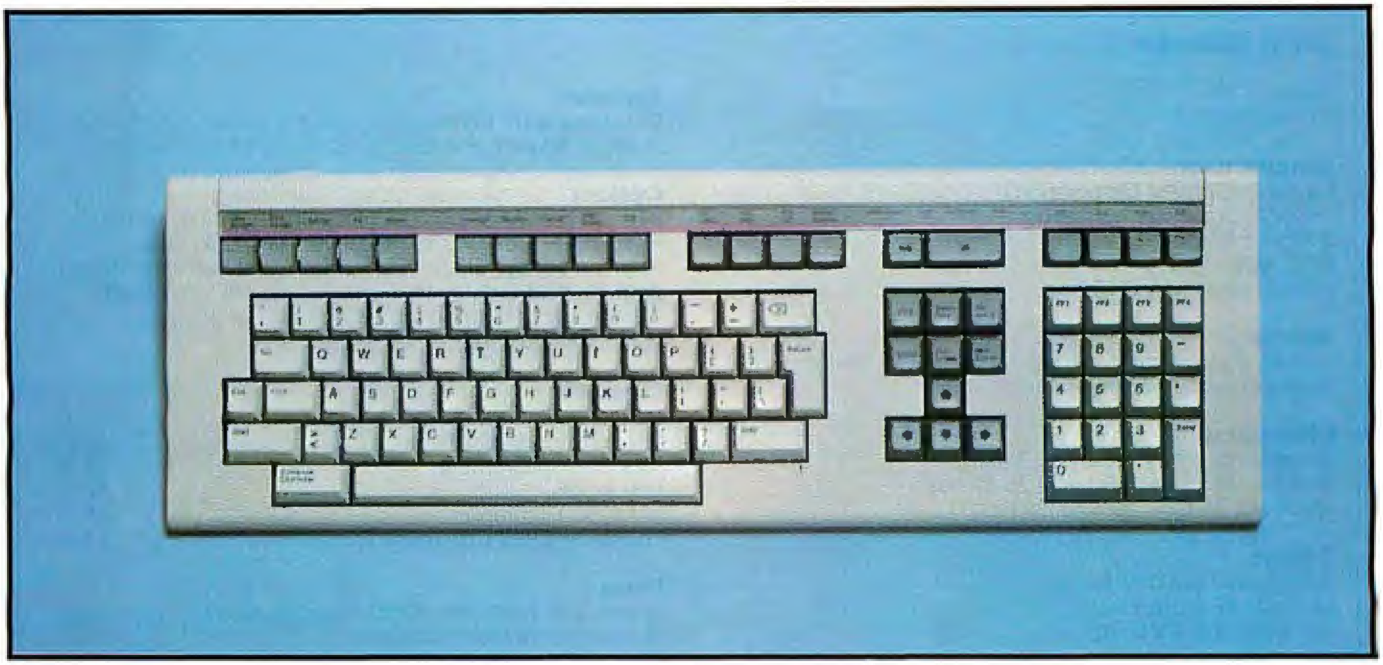

Photo 3: *The Rainbow's 105-key keyboard. Label strips (along the top of the keyboard) may be changed. Note the division of keys into four groups: the standard typewriter keys, a set of editing keys (including cursor control), a numeric keypad, and, along the top, a row of special-function keys.*

Normally the screen displays 24 lines of 80 characters each, but it may also display 24 lines of 132 characters each. Actually, the display resolutions are 24 by 83 and 24 by 137, but the extra columns are not used. Some of the Rainbow's application programs—including RED (for Rainbow editor) and the Select-86 word processor—will allow you full use of the 132-column display.

The screen is automatically blanked after 30 minutes of inactivity, presumably to prevent burning of the tube's phosphor coating. Pressing any key restores the screen with no loss of data. A setup key lets you control tab settings, scroll setting by pixel or by character, modem, and printer settings (number of bits, parity options, and so on), blinking block or blinking underline cursor, automatic key-repeat (on or off), key-click volume, and other system parameters. Scrolling by pixel rows means that the screen scrolls very smoothly instead of jumping up by character rows. It is not until you see a smooth scrolling screen that you realize how bothersome a character-row scroll can be. Setup also allows you to specify an 80- or 132-column screen, but you may not change the screen width during the running of a program (such as a word processor) without losing the display data.

The display uses ASCII (American National Standard Code for Information Interchange) characters plus foreign-language characters. A clever programmer can also gain access to what DEC calls "high-speed video," which allows a set of 32 graphics characters to be displayed. There are no dot graphics with Rainbow in its minimum configuration, but an expansion-board option provides dot-addressable graphics with a resolution of 800 pixels horizontally by 240 vertically. With an optional color monitor (and, after all, what is a rainbow without color?), you can display 16 colors in low-resolution mode (400 by 240 pixels) or 4 colors in high-resolution mode (800 by 240 pixels). With a monochrome monitor, the different colors are displayed as various gray levels. The system I had for review, unfortunately, did not have the graphics option installed, and a local dealer had only a short demo program with monochrome graphics. But what I did see was impressive both for its resolution and its speed.

The Keyboard

The 105-key keyboard, shown in photo 3, is connected to the monitor case with a thin, coiled cord and a telephone-style modular plug. It communicates with the system unit via a 4800-bps (bits per second) asynchronous serial port. The keyboard has six editing keys: Find, Insert, Remove, Delete, Previous Screen, and Next Screen. These are used a great deal in many of the Rainbow application programs. Below the editing keys are four cursor keys arranged with the left arrow on the left, the right arrow on the right, and so forth. To the right of these is a numeric keypad along with period, hyphen, comma, and Enter keys. For some reason, the plus sign, asterisk, and virgule keys are not included with the numeric keypad. Instead, along the top of the pad there are four keys labeled PF1 through PF4. Presumably they are programmable, but I haven't come across their use in any application program so far.

Along the top of the keyboard are 20 special-function keys, arranged in five groups. Among those keys is a Help key, which provides a paragraph or two of on-line instructions for various commands that the program uses. This is one of several reasons why the Rainbow

At a Glance

Name
Rainbow 100

Manufacturer
Digital Equipment Corporation
Personal Computer Marketing
2 Mount Royal Ave.
POB 1008
Marlborough, MA 01752

Summary
A solid, capable machine with superior documentation. Novice users will feel quite comfortable

Dimensions
System unit: 19 by 6.5 by 14.3 inches;
Monitor: 13.75 by 11.5 by 12.25 inches;
Keyboard: 21 by 2 by 6.57 inches

Weight
System unit: 30 lbs (13.6 kg);
Monitor: 14 lbs (6.4 kg);
Keyboard: 4.5 lbs (2 kg)

Power Requirements
115VAC, 230VAC (switch selectable), 47-63Hz, 218 watts

Processors
4.012-MHz Zilog Z80A 8-bit and 4.815-MHz Intel 8088 16-bit microprocessors

Memory
24K bytes ROM, 64K bytes RAM (expandable to 256K)

Standard Configuration
System unit (with integrated 800K disk drive, RS-232/423 printer and modem ports, 64K RAM, and space for 3 expansion boards), monochrome monitor, 105-key keyboard

Video Display
12-inch diagonal monochrome CRT, memory mapped, RS-170 composite, 80 or 132 columns by 24 rows with boldface, underline, blink, double height, and reverse video. Resolution is 800 by 240 pixels. ROM character set includes standard ASCII and foreign-language characters

Keyboard
Detached with 105 keys, including 4 cursor control keys, a numeric keypad, 6 editing keys, and 24 function keys

Options
64K or 192K RAM board, color/graphics board, second RX50 dual-disk drive, 10-megabyte hard disk, color monitor, additional communications port with high-speed path for hard disk, system unit floor stand, motorized column stand for monitor, workstation desk, system stand with castors

Software

MS-DOS	$200
Select-86 word processor	$395
Multiplan spreadsheet	$275
MBASIC-86	$250
MWC-86 C compiler	$500
Phonelink CP/M Communications	$300

Prices

System unit (with one RX50 dual-disk drive)	$2675
12-inch monochrome monitor	$325
Keyboard	$245
Extra 64K bytes RAM	$495
Extra 192K bytes RAM	$650
Second RX50 dual-disk drive	$995
Color/Graphics (not including color monitor)	$695
Color monitor	$1325
Extended Capabilities option	$500
10-megabyte hard disk and controller	$1495
Hardware manual	$50
Peripheral cable (10 feet)	$25
LA50 printer	$695
LA100 printer	$2690
LQP02 printer	$2800
System unit floor stand	$79
Motorized column assembly for monitor	$149
Workstation desk (with motorized column)	$649
Worktable and desk	$549
System stand with castors	$299

can be comfortable for beginners to use. The Do key, another of the special-function keys, is used constantly, but not consistently, in various programs I've run on the Rainbow. The meaning of the key is more ambiguous than the word "do" would suggest. For example, sometimes the key is used as a "do it" key. In the Select-86 word processor, however, it sometimes means "do it" and sometimes "abort" and sometimes "exit from mode." With the Select-86 spelling checker, the Do key means "accept."

Above the Help and Do keys are four small LEDs (light-emitting diodes) labeled Hold Screen, Lock, Compose, and Wait. These keys come on when their corresponding keys are pressed. Compose, however, is not supported by CP/M-86/80.

Most of the keys have an auto-repeat feature; that is, they will repeat if held down for more than about one-half second.

The keyboard has a fairly solid feel. If you're comfortable with a typewriter's keyboard, you should feel at home with the Rainbow's. For my tastes, though, the Rainbow's keyboard is a bit too stiff and springy. I found that prolonged typing on it was somewhat tiring.

Actually, the Rainbow's keyboard is a little confusing. For instance, the grave accent key is located where you usually expect to see the Escape key. DEC also placed an extra key between the Z and the Shift keys, just as IBM did. It is easy to hit that extra key by accident. The Caps Lock key is another nuisance; I don't like the ease with which the key is activated. I am constantly just barely hitting it as my little finger goes for the Shift key.

The System Unit

The system unit contains the microprocessors, 64K bytes of RAM (random-access read/write memory), and 24K bytes of ROM (read-only memory) that contains diagnostic routines, the bootstrap loader, and a dumb terminal program. The system unit also houses a dual

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Photo 4: *A look under the Rainbow's cover. The power supply is along the rear edge. The RX50 drive is on the right. The empty spot in the middle will accept another RX50 drive or a 5¼-inch 10-megabyte hard-disk drive.*

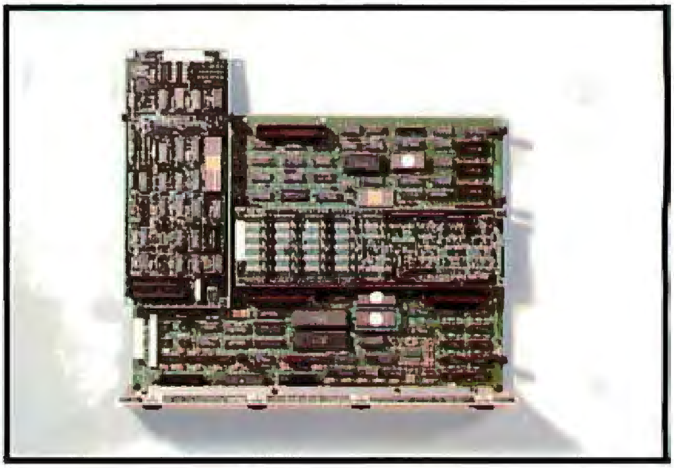

Photo 5: *The Rainbow's motherboard. The rear of the board is on the bottom. The disk controller is the vertical board on the left. The 3- by 10-inch board that runs horizontally across the middle is the optional RAM expansion board.*

5¼-inch, single-sided, quad-density disk drive, I/O (input/output) interfaces, and a power supply. Photo 4 shows the insides of the system unit.

The Z80A processor handles all the disk I/O. The 8088 handles all the other system functions and is available for running CP/M-86 programs. Both microprocessors have 2K bytes of RAM for their own use and 62K bytes of shared RAM. If they try to access the shared RAM at the same time, or during a refresh, wait states will occur, but each has access to its private 2K-byte RAM without wait states. Memory in the Rainbow 100 may be expanded to 256K bytes, but the additional RAM can be accessed only by the 8088.

Both the printer and the modem ports are controlled by a NEC 7201 multiprotocol serial controller that supports many variations of asynchronous, byte-synchronous, and bit-synchronous protocols. The 7201 has two independent receiver/transmitter channels. The printer uses one channel, configured as RS-232C/423 from 75K to 96K bps. The other channel is an RS-232C/423 modem port that supports communications from 50 bps to 19.2K bps.

The system unit can be placed horizontally on your desk or vertically with the optional stand. A lever on each side of the system unit lets you remove the cover. Underneath is an assemblage of sheet metal boxes, with only some short sections of a few cables exposed. You can push down a little spring latch under the front of the disk-drive unit and then pull it out; it comes out easily on slides. To the left of the disk drive is another slide arrangement for the optional second disk drive or for the optional hard-disk drive. The power-supply cabinet stretches across the entire rear of the unit. Where, though, is all the digital circuitry? If you turn the unit around, unscrew four large plastic screws, and unplug two cable assemblies, the Rainbow's motherboard can be slid out like a secret drawer from underneath the power supply. The motherboard, shown in photo 5, is a 10½-inch by 14-inch printed-circuit board that is supported in place principally by guides along the left and right sides. Taken out of the guides, the board is fragile—barely able to support itself. In fact, it has a plastic support beam attached to it underneath, but I would not want to trust this little beam to hold the entire weight.

The motherboard has a series of 1-inch plastic posts sticking up. It is to these posts that the disk-drive controller and optional boards are attached. It is a very clever arrangement, although it does not give you an awful lot of space. With the disk controller and a memory-expansion board in place, there is room for only two more boards (each measuring about 3 by 10 inches).

The rear of the motherboard is attached to a vertical metal plate that forms part of the rear of the system unit. The video, printer, and modem cable connectors are attached to this plate by means of two thumbscrews. Also in the rear of the system unit is a row of LEDs that serve as error indicators, in case the monitor cannot be used to display error messages.

The Rainbow's RX50 disk drive can handle two 5¼-inch quad-density, single-sided, soft-sectored disks. Each disk holds about 400K bytes, which gives you an on-line storage of 800K. The drive has two read/write heads but only one spindle and stepper motor for both heads. As a consequence, both heads always move together. This slows disk operation somewhat. Suppose, for example, that you want to read data on an inner track of disk A and write it to an outer track on disk B. The disk heads must travel together back and forth between the extremities, which takes more time than if the heads could travel independently. After a few seconds of inactivity, the drive motors are automatically turned off to reduce wear on the disks.

Because there is a single motor for two read/write heads, the upper drive wants its disk inserted label side up but the lower drive needs its disk mounted label side down, and this creates a little confusion at first. Even later on you have to be attentive to the differences. This is especially the case when moving a disk from one drive

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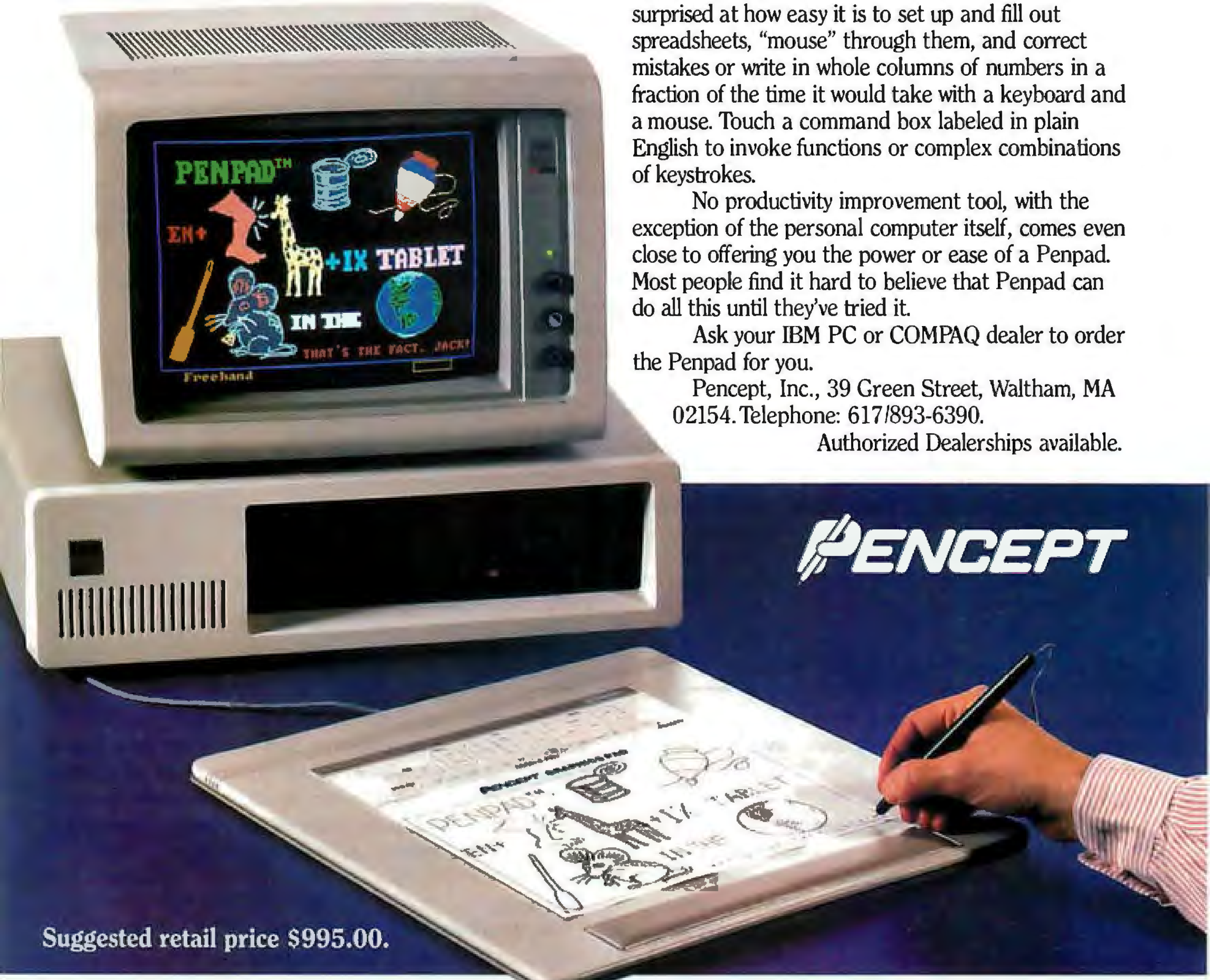

Draw your own conclusions.

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Select-86 Word Processor for the Rainbow

Select-86, by Select Information Systems, is a solid and capable system that works well with the Rainbow. You can request it to recognize the Rainbow's 132-column screen, for example. It is a text editor, formatter, and printer program. With it you can merge documents with mailing lists or spreadsheets with text files.

From Select-86's main menu you may create a new file, edit an existing file, delete a file, display a file (without editing), look at a disk directory, rename a file, print a file (in the "background," if you wish, while you are editing another file), and invoke the spelling checker.

Boldface, underline, superscripts, and subscripts are supported by Select-86 (and Digital's LA50 printer will handle all of those commands). You may format the document with headers, footers, and page numbers. You may specify left justification (i.e., flush left, ragged right), centering, and left-right justification. Flush right, ragged left—a very uncommon format—is not supported.

Select-86 comes with Superspell, a spelling-checker program. At first I thought this was not very useful because a dictionary is an awful lot faster than a computer-based spelling checker. But even a good speller can mistype a word or two. Superspell can help by proofreading your document for you. I thought it might be fun to see if Superspell recognized the word "Superspell." It didn't. "DEC" didn't pass, either. Nor, predictably, did "Wordstar" or the names of some other word processors. But it did recognize both "Rainbow" and "Select-86." Superspell's dictionary comes with just under 10,000 words, which is not an awful lot, but you can add words to it whenever you wish. Initially, you will have to add quite a few words to help it out, because it will not recognize some special words that you may use frequently (such as proper names) or variations of common words (such as "typing").

Some of the ordinary text-editing functions are a bit cumbersome to use. For example, to insert text, you must go into the "insert" mode. In insert mode, deleting something previously entered is possible only by using the backspace key. But suppose you spot a typo a few lines above where the cursor is. Then you must exit the insert mode by pressing the Do key, move to the offending spot using the arrow keys, press E for erase, move the cursor past the bad character, and press Do again. But wouldn't it be much easier to erase the mistake without leaving the insert mode? In fact, the answer is yes, and I hear that version 2.4 of Select-86 corrects this problem, but I couldn't verify it.

There are a few features that I think a good word processor ought to have, but which Select-86 does not. For instance, although tabs are supported, there is no easy way to specify that "the following words should be moved over flush with the right margin." If you want it done, you have to do it manually. There is also no way to avoid "orphans"—a single line that begins a new paragraph at the bottom of a page—unless you do it manually. That is, you have to step through the formatted document, find each page break, and, if there is an orphan, enter a command that will force an early page break. Doing so may create an orphan on the next page, so you'll have to check there, and so on. A command such as "make sure there are at least n *lines left on this page before continuing" is an easy command to install, and I wish Select-86 had it. I also wish there was a command to reserve a number of contiguous lines so that a drawing, photo, etc., of a specified size could be inserted into the final document. Once again, if you want to make sure that the lines you skip for such a space do not cross a page boundary, you'll have to step through the document and see for yourself.*

Select-86 also does not have footnoting and indexing, but perhaps you could not expect to have such features without a substantial rise in price.

For first-time users, there is a Teach program that teaches you all about Select-86's commands and capabilities. It takes an hour or so to go through the program, but you can selectively step through or come back and review parts at some later time. Not only does it tell you what the various commands and their options do, but it invites you to try your hand at some of them, and then it tells you whether you've been successful. There may be a few bugs in the program (or else it is not quite idiot-proof) because part way through one session the disk suddenly became write-protected and the program crashed. In addition, one section told me that I did not correctly do the exercise it gave me, when in fact I had done it correctly. My only other criticism of the Teach program is that when it congratulates me for doing something correctly it printed little messages that became just a bit too flippant. At times I felt as if I were being treated like a child.

to another—it must be flipped over.

Originally, only DEC-formatted disks were usable, and the formatter was not included with the system. I imagine many early purchasers of the Rainbow had experiences such as a recent one of mine: one Sunday I badly needed another Rainbow disk and no computer stores were open. Luckily, independent vendors soon met the need and developed and marketed a formatting program. Now, however, DEC includes a formatter on the operating-system disk.

To open the door on the upper drive, the instructions tell you to push on the upper part of the door with your finger. The door comes out and up like a single-piece garage door. Unfortunately, this almost assures that your finger will be caught between the door and the disk housing. There is nothing painful about it, but it sure is annoying. The lower drive door opens in a similar manner, except downward, and my poor finger gets pinched in there as well. When I think of all the garage doors that have handles on them, I wonder why the Rainbow's drive doors could not have been constructed with little pull tabs or some similar device.

Software

The Rainbow 100 comes with CP/M-86/80. CP/M's notorious line editor, ED, is included on the CP/M-86/80 disk, but it's hard to imagine that you'd want to use it when RED is provided, too. RED is a screen-oriented text editor that seems to have about the same command power as ED, but few of the drawbacks. Since it is a screen editor, you see what you're doing right on the screen; that is, you move the cursor around the screen,

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MBASIC for the Rainbow

Microsoft's MBASIC-86 (V5.22) BASIC interpreter is available for the Rainbow for $250. If you have ever programmed with a version of Microsoft BASIC, you'll feel at home with MBASIC-86. I was curious to know the speed of MBASIC-86 on the Rainbow, so I turned to Phil Lemmons' review of the Victor 9000 in the November 1982 BYTE, page 216, which lists a set of seven benchmark programs written in BASIC. They are shown in listing 1. Note, however, that the original prime number benchmark program did not define integer variables as I have done in line 0 of listing 1e. Using real variables, MBASIC-86 gave me an OUT OF MEMORY error when I tried to dimension the 7001 element array, and so I had to use integer variables to conserve memory. Table 1 compares the benchmark programs on the Rainbow 100, Victor 9000, and IBM PC systems. Overall, they seem to be fairly evenly matched.

I was disappointed with the implementation of this BASIC on the Rainbow. Many of the keys on the Rainbow do not have their expected function in MBASIC-86. The cursor keys, for example, do not move the cursor, and the backspace key acts as an old-style rub-out key; that is, it prints a back slash and then the character that is being "rubbed out," followed by another back slash. This is a confusing way to indicate a deletion.

TIME (in seconds)

Benchmark	Rainbow 100 MBASIC-86 V5.22 CP/M-86/80	Victor 9000 BASIC-86 V5.21 MS-DOS 1.2	IBM PC
Empty do-loop	8.3	7.7	6.4
Division	22.6	21.8	23.8
Subroutine jump	17.5	16.9	12.4
MID$ (substring)	25.6	24.6	23.0
Prime number	183.5	197.0	190.0
Disk-write	36.0	50.3	32.0
Disk-read	22.0	21.3	22.9

Table 1: *The timing results of the seven benchmark tests in listing 1. The first five programs originally appeared in Gregg Williams' review of the IBM PC in the January 1982 BYTE; the sixth and seventh were added in Phil Lemmons' review of the Victor 9000 computer in the November 1982 BYTE.*

Listing 1: *BASIC benchmark programs used in table 1. Listing 1a times an empty do-loop. Listing 1b tests the speed of a division operation. Listing 1c tests a subroutine call and return. Listing 1d times BASIC's MID$ function (i.e., substring extraction). Listing 1e is the Sieve of Eratosthenes algorithm for generating prime numbers. Listing 1f times the writing of a 64K-byte file to disk. Listing 1g is a disk-read program that reads the file generated in listing 1f.*

(1a)

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

(1b)

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

(1c)

```
60 A=2.71828
80 B=3.14159
100 FOR I=1 TO 5000
120 GOSUB 1000
320 NEXT I
340 END
1000 RETURN
```

(1d)

```
80 A$="abcdefghijklm"
100 FOR I=1 TO 5000
120 B$=MID$(A$,6,6)
320 NEXT I
```

(1e)

```
0 DEFINT A-Z
1 SIZE=7000
2 DIM FLAGS(7001)
3 PRINT "only 1 iteration"
5 COUNT=0
6 FOR I=1 TO SIZE
7 FLAGS(I)=1
8 NEXT I
9 FOR I=0 TO SIZE
10 IF FLAGS(I)=0 THEN 18
11 PRIME=I+I+3
12 K=I+PRIME
13 IF K > SIZE THEN 17
14 FLAGS(K)=0
15 K=K+PRIME
16 GOTO 13
17 COUNT=COUNT+1
18 NEXT I
19 PRINT COUNT "primes"
```

(1f)

```
10 CLEAR 1000
40 A$="12345678123456781234567812345678"
60 B$=A$+A$+A$+A$
80 NR=500
100 OPEN "R",#1,"TEST"
120 FIELD #1,128 AS Z$
140 FOR I=1 TO NR
160 LSET Z$=B$
180 PUT #1,I
200 NEXT I
220 CLOSE #1
240 PRINT "DONE"
```

(1g)

```
10 CLEAR 1000
40 A$="12345678123456781234567812345678"
60 B$=A$+A$+A$+A$
80 NR=500
100 OPEN "R",#1,"TEST"
120 FIELD #1,128 AS Z$
140 FOR I=1 TO NR
160 LSET Z$=B$
180 PUT #1,I
200 NEXT I
220 CLOSE #1
240 PRINT "DONE"
```

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and when you insert text or delete text, you see the results automatically. For more sophisticated applications, such as printing with formatted output and integration of files with mailing lists, you'll need a word processor. But, except for these more sophisticated features, RED looks and feels exactly like the Select-86 word processor. Since the cost of Select-86 is $595, having RED supplied on the CP/M-86/80 disk is a real boon. Curiously, the optional MS-DOS disk has only the EDLIN editor, which seems to be about like CP/M's ED.

Another good surprise is the Maint utility program. It is an all-purpose housekeeping program that has its own editor. It lets you delete files, rename files, reset file attributes, and display file contents without editing them.

There are dozens of programs available for the Rainbow, most of which are standard CP/M-80 programs. A rather extensive, annotated list is published by DEC in *The Rainbow Handbook*, a $6.95 paperback that your local dealer probably carries. Among the programs are spreadsheets, word processors (see the text box about Select-86 on page 176), accounting packages, programming languages (see the text box about MBASIC on page 178), and databases.

Documentation

Rainbow's documentation is very slick: spiral-bound, typeset pages with copious illustrations. Each manual is written in a simple, clear manner with key bits of information repeated frequently so that a complete novice is guided through every step. Documentation for the CP/M operating system has long endured a rather nasty reputation for confusion and obscurity. The manuals with the Rainbow 100, however, indicate that a major change has taken place. The CP/M-86/80 documentation is well organized and has lots of examples. This is the sort of documentation other companies might do well to emulate.

Although the Rainbow's manuals are well written, I wonder if there are too many of them. Consider what you are faced with when you first unpack the system: a little flyer telling you what to do in case the computer interferes with your TV reception; a *Read Me First* booklet consisting of 42 pages listing the errors in the other manuals; a 63-page *Installation Guide*; a 75-page *Getting Started* guide; a 110-page *Owner's Manual*; and a 258-page *User's Guide*. In addition, each separate software package has its own set of two or three guides. I think there ought to be an index to the information in all these guides. But there is help in Rainbow's computer-based instruction course, which will take you by the hand and explain the system for you, after you've finally turned the machine on and inserted the disk. The program even draws pictures of the computer on the screen. After going through the course, there is little excuse for being baffled any longer.

A sophisticated user will notice the conspicuous absence of two rather important documents—the hard-

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ware manual and the CP/M-86/80 BIOS (basic input/output system) listing. Except for the pin-outs for the serial modem port (but not for the printer port), the only description given of the insides of the Rainbow is a rather superficial gloss in the *Owner's Manual*. You can't find out such things as the processor's clock speeds unless you purchase a separate hardware manual for $50. There is no good reason for the omission of the BIOS listing. Perhaps the thought was that only systems programmers and hackers will want such a listing, and they can purchase it separately. But local Rainbow dealers can sell the BIOS listing only as part of an extensive, three-volume documentation kit that costs a whopping $315.

On the plus side, support for Rainbow users can be had in two ways. First, there is a DEC users group, DECUS (Digital Equipment Computer Users Society), that is probably one of the largest users groups in the world. It is a nonprofit organization supported by DEC and provides a library of programs, newsletters for special interest groups, and occasional national symposiums. Membership is free. Write to DECUS, One Iron Way, MR02-1/C11, Marlborough, MA 01752. Second, there are at least two independent, commercial magazines devoted to DEC computers: *The DEC Professional* (POB 362, Ambler, PA 19002-0362) and *Personal and Professional* (POB 114, Springhouse, PA, 19477).

The Rainbow 100 Plus

The new Rainbow microcomputer, the Rainbow 100 Plus, was introduced in 1983. It is essentially the Rainbow 100, upgraded in several ways, including a beefed-up power supply and an integrated 10-megabyte hard disk. The operating system is CP/M-86/80 V2.0, which, among other things, can read 48-tpi (tracks per inch) disks (Rainbow disks are normally 96 tpi), as well as IBM PC single-sided disks. (With MS-DOS V2.05 the Rainbow Plus will handle IBM XT disks.) [**Editor's Note:** *I tried using IBM disks in the Rainbow. Sure enough, the Rainbow did read them. But don't try writing to them with the Rainbow, or you'll scramble the information on the disks*. . . . R.K.] Standard memory is now 128K bytes of RAM, expandable to 896K. The necessary space for all that memory has been made available by employing 256K-bit chips. The Compose Character key, which was not supported on the original Rainbow, is implemented on the Rainbow Plus to generate overstrike characters.

Conclusion

On a scale of 1 to 10, I give the DEC Rainbow 100 a 6. For quality, I would lean toward DEC rather than toward the IBM PC. But for roughly equivalent systems, the IBM PC costs slightly less. Although the PC is perhaps more popular at the moment, the Rainbow seems to have a chance.■

David B. Suits is assistant professor of philosophy at Rochester Institute of Technology. His review of the NEC APC appeared in the October 1983 issue of BYTE. He may be contacted at the College of Liberal Arts, Rochester Institute of Technology, POB 9887, Rochester, NY 14623.

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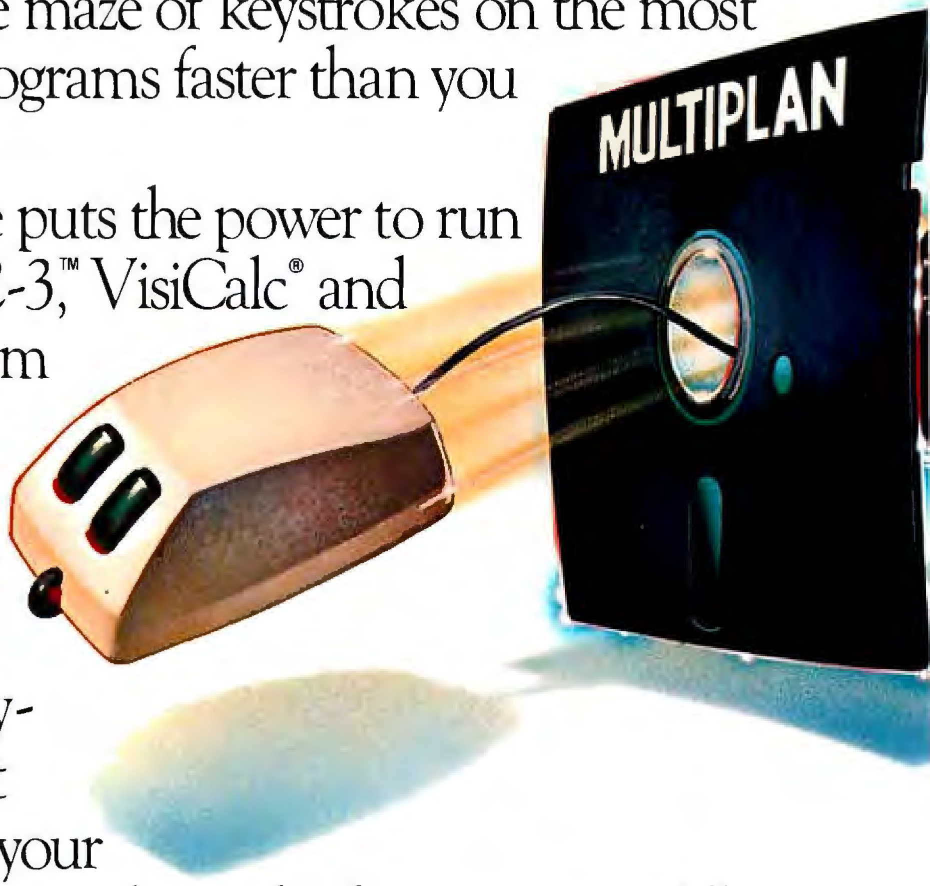

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I'll focus on Peachtext's capabilities one module at a time. One fact should be kept in mind: the individual modules began life as independent applications from diverse manufacturers. Thus, Peachtext 5000 is not truly an integrated package. Each module stands alone rather than as a section of a whole.

The Peachtext package consists of six single-sided floppy disks, two spiral-bound manuals (8½ by 5½ inches), a "quick start" card, and a box of 10 blank disks. Instead of issuing the "usual" license disclaiming all responsibility for the functionality of the software, Peachtree promises to replace defective disks and offers free technical support for the first 30 days after registration. Peachtree has a support package: a toll-free telephone number for technical support and printed amendments and updates to the package (with the option of Peachtree performing the update for a nominal fee). Best of all, support customers are entitled to a reduced rate for future upgrades. The support option costs $96 per year.

Photo 1: *The main menu of Peachtext 5000. All functions are called from this menu.*

There are five program disks plus a disk labeled "configurator." Here lies the first trap for the unwary. During the configuration process, every disk, including the configurator, is altered. Unfortunately, the documentation gives you no warning of this.

Otherwise, copying and configuration are relatively straightforward. Copy the original programs and the DOS (disk operating system) onto formatted disks. The originals are single sided. If you have double-sided drives, you can combine programs onto single disks. Next, place the configurator disk in drive A, the word-processing disk in drive B, and type PCONFG. The questions asked are simple: which microcomputer? which printer? etc. You can use one of nine letter-quality printers or a "draft printer." Presumably, the term refers to dot-matrix printers, though none are listed, not even the ubiquitous IBM/Epson MX-80. I suspect Peachtree assumes that all businesses use full-character printers.

Peachtext Word Processor

All the action in Peachtext 5000 begins with the shared main menu (see photo 1). Options are divided into three groups: document commands, disk commands, and special commands. Document commands cover editing, printing, copying, deleting, renaming files, displaying

At a Glance

Name
Peachtext 5000

Audience
Business executives

Type
"Personal productivity system" applications software containing Peachtext word processor, Random House Electronic Thesaurus, Spelling Proofreader, List Manager, and Peachcalc spreadsheet

Manufacturer
Peachtree Software Inc.
3445 Peachtree Rd., NE
Atlanta, GA 30326
(404) 239-2045

Format
5¼-inch floppy disk

Computer
IBM PC or PC XT, Compaq Portable Computer, Texas Instruments Professional Computer, Zenith Z-100

Documentation
Two volumes, spiral-bound
Lesson Plan, 207 pages; Reference Guide, 224 pages

Price
$395

disk directories, and invoking Help screens. These document commands apply only to the word-processing functions.

The disk commands serve to swap disks and change the default drive. I advise ignoring these two because they can get you into trouble too easily. Your program disk must be in drive A, which leaves drive B for data files. Peachtext expects drive A to be the default drive. When I set B as the default, I got error messages when changing programs and at unexpected points in the middle of using a module. However, to retrieve a file or write a file to disk, you must name it B:*myfile.doc*. Otherwise, you write to the program disk.

The special commands link Peachtext with Spelling Proofreader, List Manager, Peachcalc, and telecommunications. You may be prompted to change program disks after selecting one of these—depending on how you configured your working copies. (This main menu is Peachtree's effort to integrate the modules.) Peachtext 5000 does not include the telecommunications package referred to in the menu; Peachtree sells that program separately.

If you do not specify an existing document or provide a name for a new one, Peachtext automatically assigns the name WORK.DOC to the document to be edited. The Edit Status screen shows the status of the whole writing/editing process, including available workspace (see photo 2). Peachtext 5000 addresses a maximum of 128K bytes of memory. The Edit Status screen shows a total of 54,351 characters available for text. This translates as 25 to 30 double-spaced pages. The size of a file is displayed as percentage of memory and number of characters; the memory remaining is also shown. Remember, however, that Peachtext is aimed at business letters and calculations, not novels or 200-page reports. From the Edit Status screen, line width, tab spacing, margins (top, bottom, left, right) and line spacing may be set.

Editing

To begin text entry and editing from the Edit Status screen, press <Enter>. Writing a new document is easy; just start typing as if using a typewriter and the text wraps automatically. You use <Enter> as a "hard return" at the end of a paragraph or whenever you wish to leave a blank line. At the bottom of the screen, the text automatically scrolls up one line. So most new text is entered at the very bottom of the screen. Editing and entering new text takes place on the same screen; there's no need to shift modes.

Moving around in an existing document is slow. The bottleneck begins with cursor control. (Or should I say *lack* of cursor control?) Using the arrow keys, you can move one character right or left or one line up or down. The Tab key moves the cursor to locations eight columns apart. The <Home> key moves the cursor to the beginning of the current line, then alternately between the top and the bottom of the screen. <Ctrl> T takes the cursor to the top of the text, <Ctrl> B to the bottom. Function keys F1 and F2 move you backward and forward one page; shifted F1 or F2 scrolls one line. It is impossible to move by word, sentence, or paragraph. Any location not on the left edge of the screen is difficult to reach. This slow and cautious movement may not handicap an executive who uses word processing infrequently; however, for someone constantly at the keyboard, more freedom of movement is mandatory.

Short pieces of additional text may be inserted into an existing document by moving the cursor to the spot, pressing the <Ins> key (character insert), and typing.

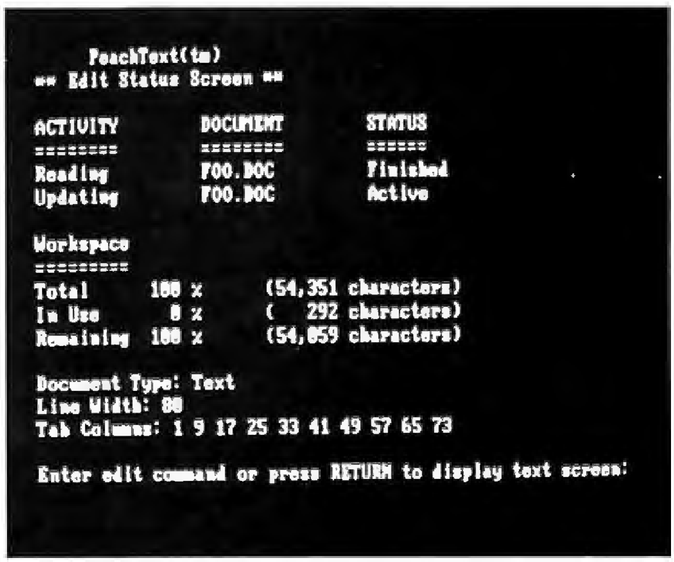

Photo 2: *The Edit Status screen of the Peachtext word processor. The screen shows the filename, its status, the number of characters used, and the number of characters remaining.*

The cursor does not change size or color to indicate that you are in Insert mode. Using another function key (e.g., a cursor or the <Enter> key) cancels Insert mode. Peachtext automatically reformats text as you write. For lengthy additions, the F8 key (full insert) clears space on the screen by moving subsequent text down. When finished adding text, press F8 again. Most function keys operate within this full-insert mode.

The <Del> key deletes a character at the cursor position. The Backspace key deletes a character to the left of the cursor but will not travel past the left margin of a line. F4 deletes the word to the right of the cursor. Pressing F9 twice deletes the line to the right of the cursor. Although this does offer some protection from accidental deletion, after you have deleted one line you need only press F9 once to continue the destruction. A buffer that temporarily saves deleted text would offer more protection.

Blocks of text to be moved, copied, or deleted must be identified by marking the beginning and end of the block of text with the F3 key. Then you use the <Esc> key to exit from the text to the Edit Status screen. At the backslash (\), you can type the commands to copy, delete, or extract the text. Unfortunately, you can no longer see what text you are manipulating or where it is going. You must have exactly two block markers in the text. More or fewer markers results in an error message. Confusion is possible: the mark left by the F3 key is identical to the formatting command mark for underlining.

As with all other deletions, text deleted as a block is text lost. Peachtext displays a "Deleting *n* characters" message (*n* equals the number of characters in the block) and asks for confirmation. I find it difficult to confirm destruction of sentences I cannot see.

The search and replace capabilities of this package are the standard varieties found in other word processors, but there's one difference: all its variations are invoked by one key. Where some word processors (e.g., The Final Word) have search, global replace, and query replace (i.e., Do you really want to do a substitution here?) capabilities, Peachtext uses multiple presses of the F6 key. You may specify that you want to repeat an operation a specific number of times. There is no query replace.

Pressing F6 produces a previously unseen message line at the bottom of the screen. You type in the word or words to search for, then press <Enter>. F5 repeats the search. To search and replace, you press F6, type in the string to be located, press F6, and type in the replacement. If you press F6 a third time, you can specify how many times you wish the action repeated. Just pressing <Enter> replaces only the first string found.

The Search function is case-sensitive, so the desired word must be typed in exactly as it appears in the text. If you use all lowercase letters, the Search won't find the word at the beginning of a sentence. If you capitalize the first letter, it will ignore the same word in lowercase. Without query replace, you must be careful how you specify a word. Otherwise, it may find the given letter combination in the middle of a word: when replacing "the" with "this," the word "other" will be changed to "othisr."

Peachtext searches the text from the current cursor location to the end. It neither performs a backward search nor does it wrap from the end back to the beginning and come to rest at the original starting point. The task is further complicated by a lack of understandable messages. Substituting the prompts "Search for:", "Replace with:", and "How many times:" for that tiny colon wouldn't have been all that hard when the program was adapted to the IBM Personal Computer (PC).

If you like to page back and forth between locations in your text, Peachtext probably isn't for you. First, there's a shortage of road signs. There is no status line with page, line, or column counter to tell where you are currently working. Second, there is no easy way to leave a place marker in the text and find it again. Instead, you must type in a unique identifier, move to the beginning of the document (no backward searches, remember?), search for the desired information, move again to the top of the text, and search for your identifier.

Peachtext is right on target when it comes to merge capabilities. There are more ways to create customized letters than one review can describe. Mailing lists may be created within Peachtext with its Variables functions or with a separate module, the List Manager. Individual paragraphs can be labeled, either in one file or as individual files, and called in as desired. Once you get past the too-brief documentation, Peachtext outperforms Wordstar's Mailmerge.

Printing Documents

Text formatting and printing options are also very powerful: left, right, or center justified, margin changes in midtext, printing text to screen (instead of to a printer) for review, headers, footers, underlining, and more. Formatting is achieved by commands set from the Edit menu, embedded in the text, and entered at the keyboard when the Print Status screen is displayed. The Print Status screen reflects information Peachtext found at the beginning of a document prior to the first text character.

When faced with a trade-off between screen-orientation and formatting capabilities, Peachtree went for formatting. As a result, your printed document may not look like the text displayed on your video screen. Text can, however, be printed to the screen. In some cases, the results will still be approximate because monitors can't show proportional space nor display more columns than the screen holds.

One area affected by the lack of screen orientation is Peachtext's inability to scroll horizontally past 80 columns, although the formatter permits a maximum printing width of 132 characters. But in my experience this is not really a problem.

I especially like the ability to place nonprinting comments within text. By typing the * command at the beginning of any document, you can track the latest revi-

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Can be used with CROSSTALK-XVI or Smartcom II software	Yes	Yes
Regulated DC power pack for cool, reliable operation	Yes	**No**
Eight indicator lights to display modem status	Yes	Yes
Speaker to monitor call progress	Yes	Yes
Attractive, compact aluminum case	Yes	Yes
Two built-in phone connectors	Yes	**No**
Compatible with The Source and Dow Jones News Retrieval	Yes	Yes
Unattended remote test capability	Yes	**No**
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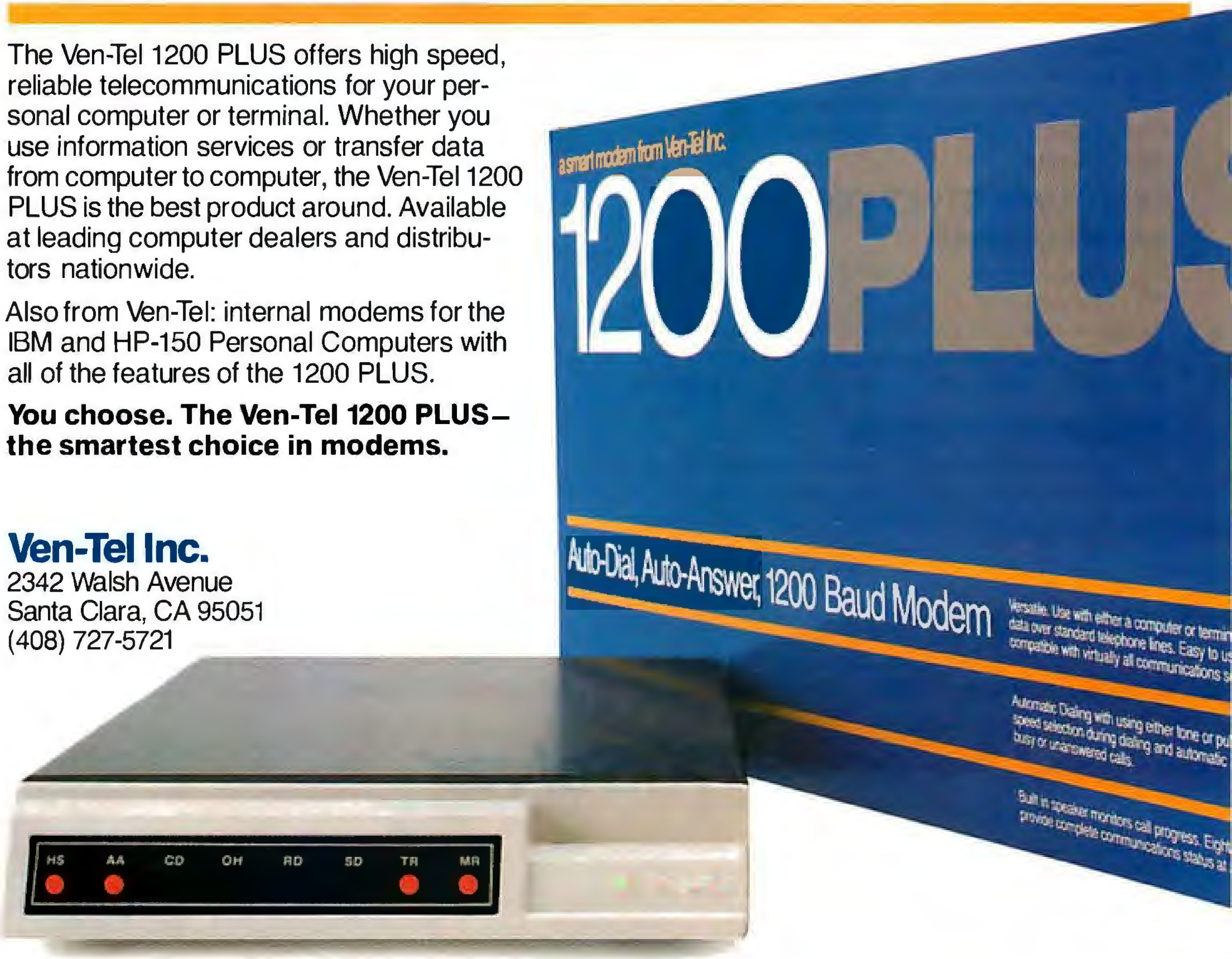

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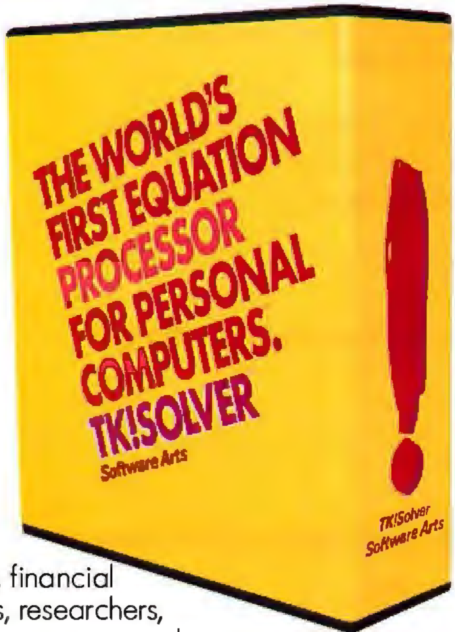

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Photo 3: *One of the Help screens available from the main menu.*

sion, summarize content, or leave a note to the next person who uses the file. A second plus is being able to add information directly from the keyboard at print time, using variables and the Get command.

I use an IDS Prism 132 printer, capable of true proportional spacing, underlining, boldface type, superscript, subscript, and several acrobatic tricks like dot-addressable graphics. Although Peachtext offers many formatting and printing options, I could not get them to operate on my printer. I've used other word processors that didn't include the Prism on the list of compatible printers. Most of the time, I could send control codes directly to the printer and thus take advantage of all the program's formatting options. Peachtext overrode control codes I sent before entering the program and ignored special characters sent from the keyboard at printing time. [**Editor's note:** *Peachtext contains the Out command that is designed to send control sequences to printers....* **A.A.L.**]

Saving Text

There are four ways to end an editing session and five ways to save a file to disk without exiting from Edit mode. All are invoked from the Editing Status screen. Typing End at the backslash saves your text. END= <Document> saves your text under a new name. The Quit command bails you out without saving the changes, and Quitx exits while saving temporary documents on disk.

To write memory to disk, you again start at the Editing Status screen. W saves all text in memory to disk; Wn saves *n* lines. WC saves all text from the beginning of the document to the cursor. WR is useful for long documents that do not fit into memory. When you first retrieve a document longer than 40 pages, only part of it is read from the disk. After editing this section, press <Esc> to return to the Edit Status screen. At the backslash, type W and press <Enter>. When the computer has stopped writing to disk, type R and <Enter>: the next section of the document is retrieved. WCR writes all text from the beginning to the cursor and then reads an equal number of lines from the disk into memory.

Peachtext's six Help screens can be summoned from the main menu by typing a question mark followed by <Enter>. These screens cover menu functions, recognition characters, edit commands, print commands, variables, and data files (see photo 3 for the Print Help screen). From the Edit Status screen, additional help is offered: read, write, include, kill, print, end, quit, and others. Oddly enough, the use of the arrow and function keys is listed nowhere.

Spelling Proofreader

After working with Peachtext, the next logical step is to check your spelling. First, you save the document you were working on. Selecting SP from the main menu starts the Spelling Proofreader. Once at the menu, you can choose from the following options: Spell Check Document, Maintain Dictionary, Change Default Table, Get Help!, and End Spelling Proofreader.

The program is the fastest spelling checker I've used. It provides a running tally of the number of words checked, the percentage of unique words, the number of words it can't locate in its 20,000-word dictionary, and the percentage of unmatched words. Note that I've said

You can use the Random House Electronic Thesaurus while editing your document.

spelling checker, not editor. Once Spelling Proofreader is finished comparing words with it's dictionary, your work begins. Words are presented alphabetically, one at a time, stripped of context. For each unmatched word, you can choose to add it to the dictionary, accept it as correct, or mark it for later correction. You can't correct it during the proofreading—you can only mark it as wrong.

Alternately, you can review all the words as a group and accept, correct, or add all the words to the dictionary with a single command. This process works well if you know everything is misspelled or that this group represents the latest technical jargon you want Spelling Proofreader to learn; otherwise, group review is worthless. In either case, you have to return to Peachtext to change misspelled words. That's a disadvantage; the better proofreading programs both check and correct. Some can even help find possible spellings and can recognize words corrected earlier in the run. The first time you write a word, you have to spell it properly. Every time after that, the program just wants a confirmation of the change to be made. That's handy when you spell the same word wrong 15 times in one article.

The Maintain Dictionary function enables you to review what words are in a particular section of the dictionary. You enter a letter or word at which to begin and a letter or word at which to end. Then, the words fly by on the screen too fast to be read. However, it does report the number of words that fall within the range.

When I requested a list of all words beginning with Q, I was given 78 words.

You may add and delete words from the dictionary or combine two dictionaries into one. When you press M, Spelling Proofreader automatically alphabetizes new words and discards words marked for deletion. The Default tables tell Spelling Proofreader which dictionary to use for proofreading and the symbol to use in marking incorrect words.

Random House Electronic Thesaurus

The Random House Electronic Thesaurus has the ease-of-use capabilities that Spelling Proofreader should have. First, you can use it during the writing process: you don't have to exit from Peachtext. Second, changes are made immediately: you needn't go back to manually enter the desired word.

During editing, position the cursor on the first letter of the word for which you need a synonym. Press the F10 function key and, quick as a wink, a wealth of words appears on the lower part of the video screen. Although Thesaurus comes on a separate disk, there is enough room for both Peachtext and Thesaurus on a double-sided disk.

By pressing the right and left arrow keys, you can try alternatives until you have the word you want. Press <Enter> and the substitution is made. If you don't like the choices, pressing the <Esc>key takes you back to Edit mode.

To increase the chance of a successful word match, use the simplest form of a word and add -ed, -s, or -ing endings after using the thesaurus program. The keyword list is limited, though not quite so badly as the spelling checker's dictionary of words.

The Random House Electronic Thesaurus has more synonyms than keywords, and there is no cross-index. If removing endings doesn't work, you may be forced to think of a synonym yourself before you try the thesaurus program again.

List Manager

List Manager is designed to maintain mailing lists and other short files and to serve as a source of information for Peachtext. It is not a full-function database manager. Field names may be up to 14 characters long. Lists are restricted to 14 fields, but no field length is specified. The *Peachtext 5000 Reference Guide* does comment that item length should be as short as possible because this influences the number of records that will fit on a disk.

DF (Define File) is used to create a new file. After designating a name and title, you specify the name and length of the fields. Within the fields, the F1 and F2 keys are used to move the cursor from one field to the next. Changing field names or values and adding additional fields is easy during this phase. You may also set a default value for a field.

Each file is indexed by the fields you defined, and indices may be changed at a later date. You may select up to three sort fields. One field serves as the primary in-

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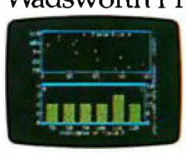

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dex, used by List Manager to organize the records (e.g., name or company). Zip code might be your secondary index on a mailing list. The final step in creating a List Manager file is specifying how many records you anticipate entering in this file. List Manager indicates how many records would fill the disk, which is an extremely useful piece of information. If the space is insufficient, press <Esc> to change the information you entered or substitute a new disk.

To add records to a file, select UF from the List Manager menu. UF is a cross between Search and Add. List Manager assumes you are correcting an existing record. In order to present you with a potential match, it asks how you wish to look up an entry and asks what information you seek. You may reject the entry, in which case another potential match is produced. If a matching entry is not found, List Manager offers you a new record page with the information you provided placed in the corresponding field. For example, suppose you have defined a file called Party. The file contains names, addresses, telephone numbers, and favorite foods. You decide to index by name, zip code, and food. Now you start adding friends to the file. The first few are quick—no matches. But what happens if you have 21 friends named Malloy? Entering each name becomes more arduous. The same routine is necessary to locate a record to be deleted. Select UF, find the record, and type D at the Accept prompt. Before erasing, you must verify that you truly wish to delete this record.

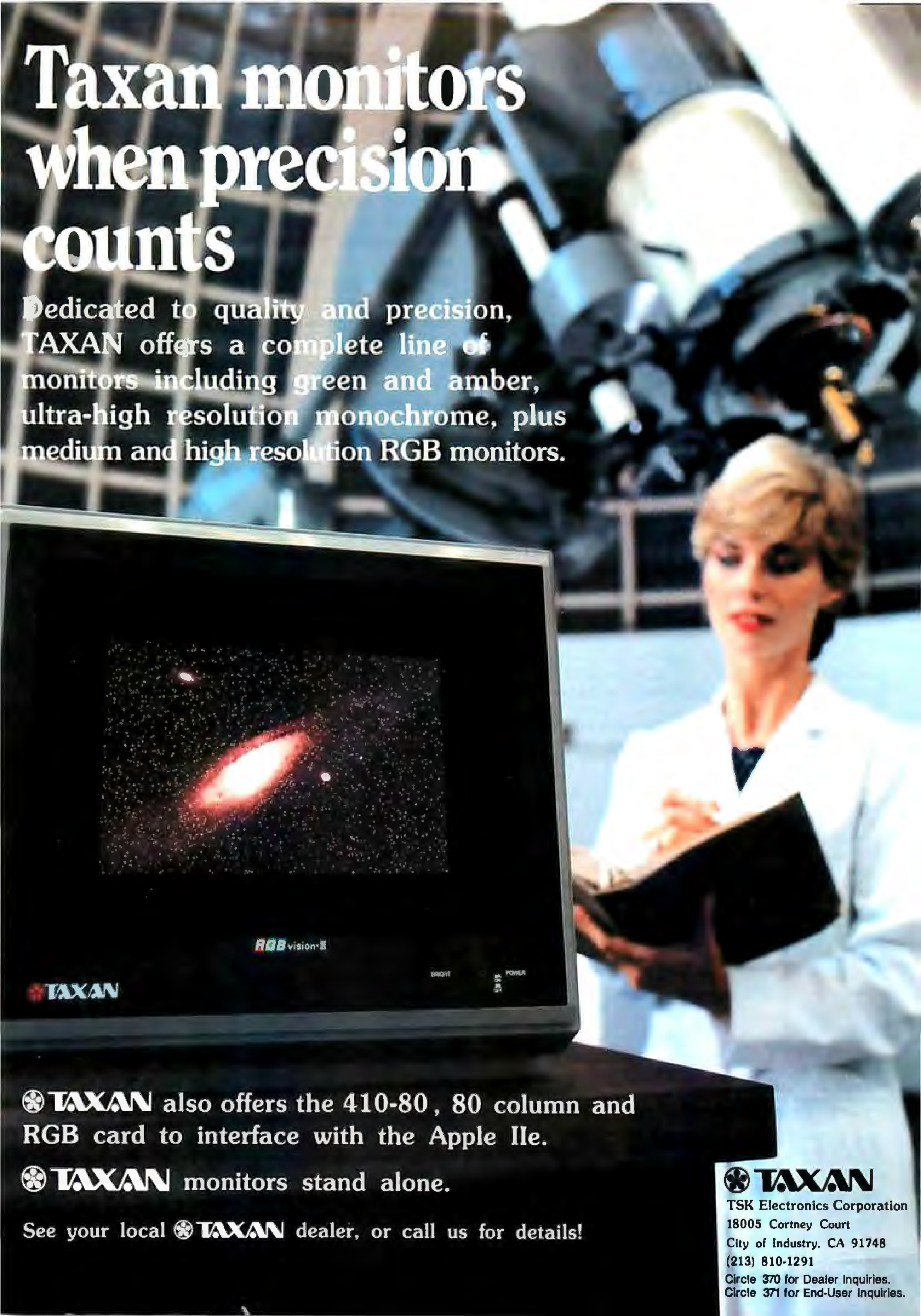
Information in a file may be sorted several ways to generate labels, lists, and reports. Wildcard searches, in which not all characters are specified, are possible. Relationships may be less than, equal to, or greater than a value given. AND and OR are operational bases of selection. There is one peculiarity: in order to sort numbers properly, you must use preceding zeros (i.e., 001, 002, etc.). If you don't, both 1 and 100 would be listed before 2.

Possibly the best reason to use List Manager is its ability to combine with Peachtext for individualized letters. If your main use of word processing is mass mailings, List Manager makes the Peachtext merge capabilities shine.

The Produce Report submenu enables you to specify print format, sorting keys, and where to print (screen, disk, or printer). A second function, DP (Define Print Format), is used to determine exactly how the output is printed—on labels or on envelopes. Both are necessary when merging a List Manager file with a Peachtext document for individualized letters.

Files may be redefined by using DF (Define File) followed by CF (Combine Files). This works well when adding or eliminating fields from a record, but if all you want to do is change a field name, the process seems needlessly laborious.

The program is simple, but the documentation is very confusing. I never found a clear explanation of the difference between PR and DP or precisely when each was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to be used. The List Manager Help function is equally terse. One- or two-sentence explanations are given for each item on the List Manager menu.

Peachcalc

You can reach Peachcalc from within Peachtext or directly on start-up. Your first time through, type a question mark before starting to work on the spreadsheet. The Help screen explains how to move the cursor and some basic text-entry information. This is only the first of many Help screens. Throughout the program, even while entering a complex command, you may type ? on the status line to get a list of options and results relevant to that operation.

The spreadsheet is 63 columns wide (A through BK) and 254 rows deep. Data is entered into the worksheet one cell at a time. Numerical information is limited to 16 significant digits plus a decimal point and an optional sign. Text is limited to 115 characters and must be preceded by a single or double quotation mark. Columns may be up to 126 characters wide. Formulas may not exceed 116 characters.

Movement from one cell to another is done with the arrow keys or, for larger jumps, by typing the equal sign (=) and a block address. The worksheet may be split to display two separate areas. These windows may be scrolled together or scrolled independently.

Worksheet information is given on three lines at the bottom of the screen. The first of these lines is the status line. It contains the current direction of cursor movement, the name of the active block, format, and contents of the block. Error messages appear on the far right of this line. Current block width, usable memory, and available options appear on the prompt line, located immediately below the status line. New information is typed on the entry line before being written to a particular block. The number at the beginning of the line changes to reflect the number of characters typed.

All commands are invoked by typing a slash and the first letter of the command on the entry line. Like Supercalc, on-line command prompts are single letters. The Format command (/F) is used to set options for the numeric display (decimal, dollars rounded to nearest cent, decimal fractions rounded up or down, etc.), text display, column width, and to protect data integrity. The Global command (/G) is a su' iet of Format and determines whether a particular command applies to a whole worksheet or to a subset only.

The amount of data in a cell is independent of the column width (i.e., if you have a 15-digit number on your entry line, Peachcalc displays as much of the number as it can and keeps the rest in memory). Given a column width of 10, only the first 10 digits appear on the worksheet. Hidden numbers are displayed on the edit line when the cursor rests on that cell. If the entry is a label, the excess characters overflow into the adjoining cell if that cell is otherwise unused. Information in a cell may be numerical or textual (such as a label). Either a formula or its results may be displayed. When you are edit-

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ing a box, the original formula appears on the status line.

Peachcalc has strong replication abilities. The Repeat command (/R) can be used to copy one block or many blocks, one time or many times. Starting a label with a single quote prints it across a whole row.

Worksheets may be saved to disk using the Save (/S) command. If you try to exit Peachcalc with your file unsaved, the program prompts for a yes or no decision because worksheet data is not saved automatically when you quit. The Zap (clear everything) command is also a possible hazard. Although Peachcalc requests a yes or no before responding to your /Z, the wrong choice can leave you with an empty worksheet and no way of recovery.

Peachtree offers a separate graphics program to produce pie charts and a few other graphs. Within Peachcalc, you can print rows of asterisks or other symbols for a Visicalc-style bar chart.

Documentation

I've saved the documentation until now in order to examine the user manuals as a unit. Documentation is crucial to any program. The better the documentation, the easier the program is to learn, and the lower a user's frustration.

Of the two manuals containing operating instructions, most novices will turn first to the *Lesson Plan*, which offers a rapid tour through each module. I particularly liked the word-processing lessons, in which a user is asked to help Abe Lincoln rewrite the Gettysburg Address. It's cute, at least the first time through. The other lessons show no such humor.

The larger manual is the *Reference Guide*. It begins with installation instructions and an overview of Peachtext 5000. Each section discusses concepts and major functions of the program. The whole manual suffers badly from brevity. Thirty pages isn't enough to explain spreadsheets. The Visicalc manual is eight times as long.

Chapter 1 in the section on Peachtext is entitled "The Peachtext Menu." The authors hurry through their discussion of the main menu. Chapter 2 deals with creating and editing a document; topics are arranged semialphabetically, not logically. Chapter 3 covers "Recognition Characters." Printing and formatting are covered in Chapter 4. Chapter 5, dealing with variables, covers one of the most complex functions of Peachtext in very few pages.

Both Spelling Proofreader and List Manager discuss each menu option in turn. Although they suffer from a shortage of examples (which is true of the whole manual), the sections on Spelling Proofreader and List Manager are perhaps the most logically organized. The Thesaurus is slighted, with only a scant three pages of information.

Chapter 1 of the Peachcalc section is labeled "Concepts" and offers a combination of definitions and functions. Chapter 2 tours the worksheet: how to move, the status line, the prompt line. Chapter 3 covers the status, prompt, and entry lines. The / commands are described next. The final chapter lists formulas and functions recognized by Peachcalc.

The appendix of the main manual contains summaries of Peachtext and Peachcalc commands. A section on customizing and maintaining the programs follows. Though not mentioned in the table of contents, error messages are discussed at the end of each appendix.

The lack of indexes further decreases the manual's usefulness. Although the manual is divided into sections for each program, you can spend hours thumbing back and forth between the two books as you work your way through creating and printing a document.

Peachtext 5000 as a Single Package

Examined one at a time, the Peachtext 5000 modules belong in that crowd of programs that do the job adequately. They're not superstars, but neither are they real villains. You don't love a calculator or telephone, you just use it.

When you attempt to evaluate Peachtext 5000 as a whole, the picture changes for the worse. Peachtree labels the package a "personal productivity system." I'm not sure what they mean by that. I see it as a series of individual programs loosely tied together by a narrow ribbon—the common main menu. Given the diverse origins of the pieces, it's no surprise that the ribbon is not too tight.

Peachtext began life as Magic Wand, a program popular long before the IBM PC appeared. Peachcalc is an alias of the original version of Supercalc; Supercalc, though newer than Magic Wand, is still of the same generation.

The three other modules are equally diverse. Peachtree acknowledges Random House as the source of its thesaurus package. There is no identification of the source of Spelling Proofreader. (Aspen Software sells a Random House spelling checker with dictionaries ranging from 20,000 to 50,000 words.) List Manager was written by Peachtree, as far as my sources know.

The weak point of Peachtext's integration is commands. In any program, consistency of function is crucial to good design. Peachtext 5000 is inconsistent in how commands are given and, more crucial, in what commands mean. There is no excuse for confusion over how, when, and where to enter commands and which commands to use. The first step in ending the mess is better documentation. The second step is to really adapt the pieces, not just stick a common menu up front. Instead, Peachtext includes some functions that are invoked by the dedicated function keys, others are called from a slash on a status/editing line within the workspace, and some require exiting the current work to a separate status screen with a backslash. I lost count of the number of times I tangled up the slash of Peachcalc with the backslash of Peachtext.

In Peachcalc, typing the slash command marker calls a prompt line to help you make your decisions. If you

get lost in the middle of a command, typing a question mark invokes a Help screen with all possible choices for that particular situation. At the Peachtext backslash, you may enter a single character followed by <Enter> or a combination of characters followed by <Enter>. The only way to know which command uses which pattern is to know the program well or to keep the reference guide open. There is no prompt line, and Help is a separate function not accessible once you have entered other information.

To further confuse the matter, List Manager and Spelling Proofreader do not use either form of command marker. Functions are called from the program menu only. And each module uses its own variations on function keys. It's hard to be productive when you are drowning in conflicting, inadequately documented commands.

As much as I dislike shuffling disks, I'm not downgrading Peachtext for using five program disks. Most users won't be trading modules that often. If you have ever used a compiler, you know you can spend all day swapping disks between phases of creating a program.

Final Words

Is Peachtext 5000 a winner or a loser? It's not a package I find congenial to use. You'll have to total up the final score yourself.

The merge and formatting capabilities of Peachtext are pluses, and they are definitely above average. Printing is very good if you have one of the printers listed; otherwise, it's only fair. Peachtext does an adequate job on draft printers. Block manipulation is average; cursor moves are poor.

In terms of ease of use and convenience, the Random House Electronic Thesaurus rates as very good. A larger vocabulary would raise that score to excellent. Although it's fast at matching words and multitalented at adding and subtracting words, Spelling Proofreader is a weak link in Peachtext 5000. The fatal flaw is its inability to correct words.

List Manager earns a good grade for its flexibility, especially the report-generation facility. Although I dislike the routine to add records, it is counterbalanced by List Manager's ability to supply information to Peachtext for customized letters.

Peachcalc is a solid package. It is not a 1-2-3 or a Supercalc 3, but judged on its own merits, the electronic spreadsheet is the best part of Peachtext 5000 and deserves a rating of excellent.

Documentation is the major flaw. Over half of the problems with Peachtext 5000 are caused by inadequate documentation. Even Peachtree's enlightened support policy doesn't compensate for the documentation. As I said earlier, bad documentation is a preventable crime. With an index, better organization, and a readable layout, the manuals would be infinitely more usable.■

Stevanne Ruth Lehrman (15 Larkspur Rd., Newton, MA 02168) is the founder of and vice-president of product evaluation for Analytic Resources. Her specialty is competitive analysis of software and documentation.

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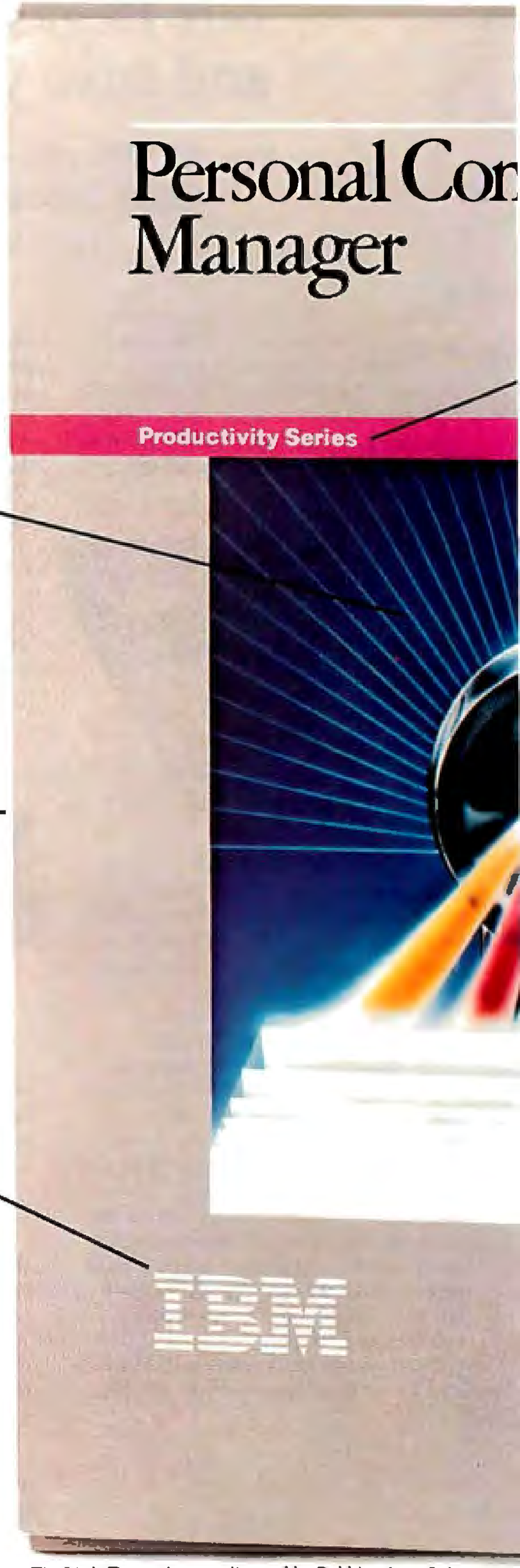

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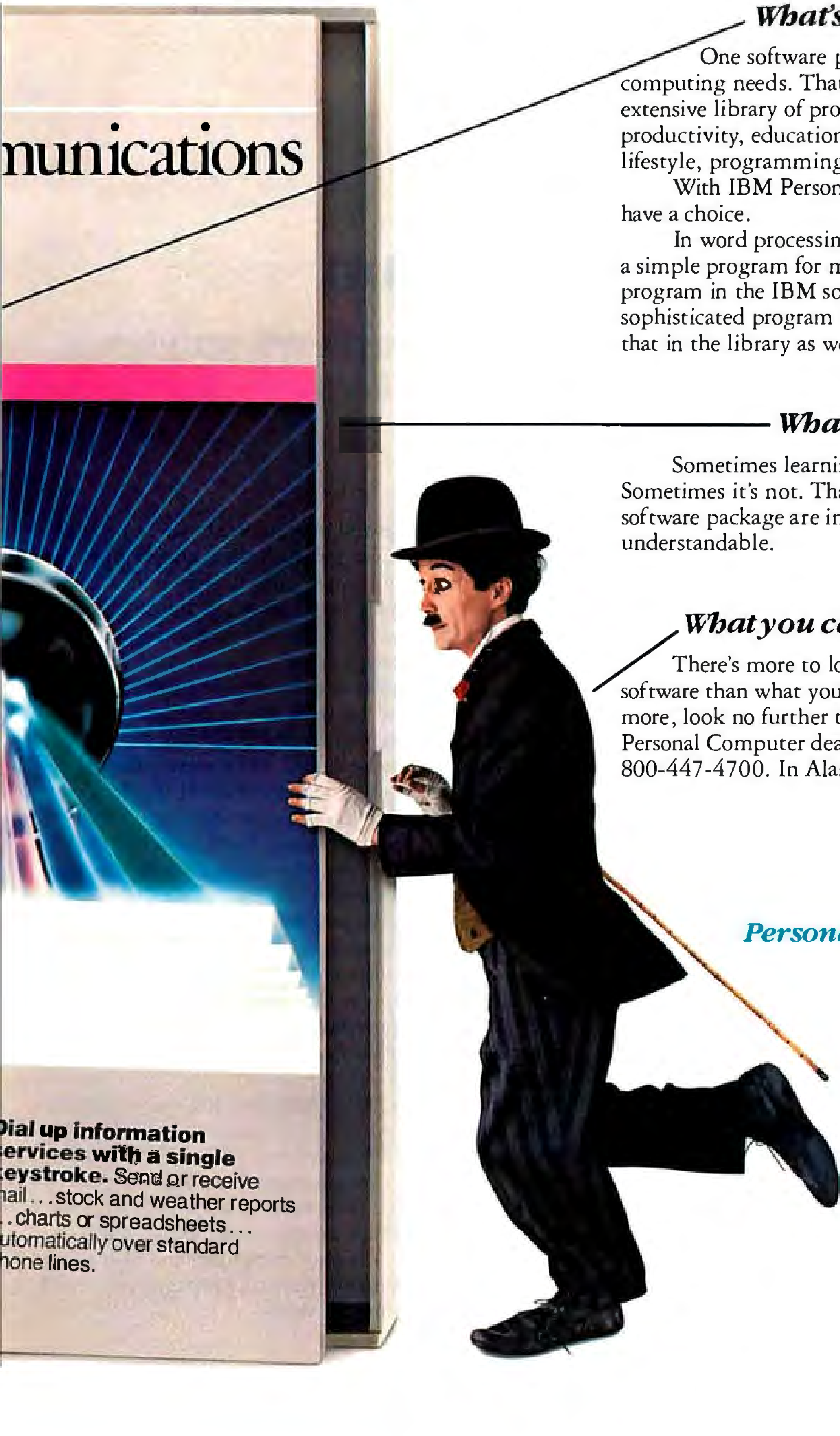

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The Coleco Adam

This inexpensive home computer has all the necessary peripherals, but using it is no Garden of Eden

Jules H. Gilder
Computer Consultant

In the past few months, you've probably heard a lot about the new Coleco Adam computer. With its built-in word processor, Applesoft-compatible BASIC, letter-quality daisy-wheel printer, 80K bytes of RAM (random-access read/write memory), ability to use all Colecovision game cartridges and accessories, and a price tag of less than $750, it sounded too good to pass up. It is often said that if something sounds too good to be true, it probably is. The Coleco Adam is no exception to this rule.

There are two versions of the Adam computer. The machine used for this review is a stand-alone unit with a Colecovision game system built into it (see photo 1). The other version consists of an expansion module that plugs into an existing Colecovision game system and converts it to a computer. The one feature of the Adam that I have had no problems with is its ability to function as a video game. After producing hundreds of thousands of these game machines, Coleco has that process down pat. Would that it were so for the rest of the system.

The Adam comes in three parts. The main system console includes a Colecovision game unit, main processor and memory, digital data pack (cassette) drive, and expansion interfaces. The daisy-wheel printer includes the only power cord for the system, passing power to the main console using the same cable that sends printer information back. The keyboard is connected to the main console with a coiled telephone-type cord. Two Colecovision joysticks (one of which can be mounted to the keyboard using an adapter that comes with the system) and three digital data packs are also included. One tape contains SmartBASIC, one is a preformatted blank tape to store programs or word-processing files, and the third is a game, Buck Rogers Planet of Zoom (see photo 2).

Plugs and Slots

The Adam has several interfaces for communications and expansion. Power for the system comes from the printer, which uses a single cable to send power to and receive printer signals from the main console, making it difficult to tap into that signal to use a different printer. Next to the printer/power plug on the left side is a standard modular telephone plug marked "Adamnet"; the plug is to be used for an optional modem. Another telephone plug on the front of the console is used to connect the keyboard. On the right side of the system console are two standard nine-pin joystick connectors and a Colecovision expansion interface for attaching Coleco's add-on modules for its advanced games.

Under an easily removable top are three expansion slots, next to the connectors for the installed tape drive and for an optional second drive (see photo 3). Also on top is the Colecovision game-cartridge slot. On either side of that slot are two reset switches: one resets the machine as a computer, the other resets it as a game.

The Adam's peripherals are connected to the main console via a network called Adamnet; each peripheral contains its own 6801 microprocessor. The main system microprocessor is a Zilog Z80A. Four 6801s are used: one as the Adamnet controller and one each in the printer, the keyboard, and the tape drive. Although Coleco has touted the system's resultant multitasking capabilities, systems delivered to date support only the most rudimentary form of multitasking: while a user plays the Buck Rogers game, the tape drive loads the next video screen. The system cannot work on a separate task while the printer is printing, however.

Screen Memory

A personal computer stores its display screen in a sec-

Photo 1: *The Coleco Adam includes a tape drive, a printer, 64K bytes of RAM, a keyboard, a Colecovision game system, and two joysticks.*

tion of memory, which is used by a video processor (in this case, the Texas Instruments 9928) to generate a TV image. In most computers, this memory can be addressed by the main processor, and it can be changed using machine language or POKE statements to put the appropriate values into memory locations. In the Adam, however, the 16K-byte video memory is not addressable from the Z80A microprocessor. The 9928 has its own operating-system software to store video information, which can be used either by the Z80A or the 9928, but Coleco provides technical information on this only to licensed software developers.

Because this memory is not directly accessible by the system's main processor, PEEK or POKE commands cannot be used to locate screen information, and screens cannot be transferred using BLOAD or BSAVE commands. Thus, although Coleco's SmartBASIC is partly compatible with Applesoft, programs that use POKE or BLOAD to insert information directly into either the text or high-resolution screen won't run on the Adam. Because the screen memory in the Adam is not memory mapped as in the Apple, programmers will need more technical information to achieve faster high-resolution graphics action than is possible using BASIC. Coleco said a technical reference manual will be available by early summer.

High-Speed Tape System

One of the technical breakthroughs that can be seen in the Adam is its low-cost, high-speed digital tape system. Although most hobbyists snobbishly turn up their noses at the mere mention of tape storage, Coleco has done an impressive job on the Adam's tape drive. To begin with, everything is automatic and transparent to the user. In fact, the tape commands are virtually identical to the disk commands used in Apple's DOS 3.3, with a few exceptions.

One change I dislike is the elimination of the powerful DOS 3.3 EXEC command, which enables ASCII (American National Standard Code for Information Interchange) files to be read in and appended to program files. Because programs are stored in ASCII format, the differences between the LOAD command and the EXEC command may have seemed to Coleco small enough to abandon the latter. The manual suggests no way to combine two ASCII program files, which is what the EXEC command was used for. Storing programs as ASCII files means they can be easily edited by the word processor, but it also means they require considerably more space on the tape and take longer to load than tokenized programs.

The Adam tape drive operates at two speeds: fast and faster. It reads and writes to the tape at a speed of 19,200 bits per second (bps), or 20 inches per second (ips), according to Coleco. In search mode, it scans the tape at 80 ips.

"Blank" tapes are preformatted with information that tells the tape drive where the head is currently located, much as information on a floppy disk tells the disk drive at which track and sector the head is located. A catalog stored on the tape indicates where each file is kept. The drive switches to its high-speed search mode to properly position the tape and uses its low-speed mode to read data from the tape.

At A Glance

Name
Coleco Adam

Manufacturer
Coleco Industries Inc.
999 Quaker Ln. South
West Hartford, CT 06110
(203) 725-6000 or (800) 842-1225

System Unit

Size:	18¾ by 10⅜ by 4⅛ inches
Processor:	Zilog Z80A
Memory:	80K bytes expandable to 144K bytes; 16K bytes of that memory is dedicated to the video display
Interfaces:	Three expansion slots under a removable cover; one Colecovision expansion slot; one Colecovision game-cartridge slot; four-wire telephone-type jack for Adamnet; nine-pin connector for printer signals and power; two 9-pin joystick plugs; four-pin telephone-type jack for the keyboard
Mass storage:	One 256K-byte digital data pack (cassette) drive; room for optional second drive ($200)

Keyboard

Size:	15⅛ by 6½ by 2¼ inches
Features:	75 full-travel sculptured keys in standard typewriter layout, including six numbered programmable function keys, six word-processing command keys, and five cursor keys; a 12-key numeric keypad, accessible only from the word processor; auto-repeat on all keys

Printer

Size:	15⅜ by 14⅛ by 5¾ inches
Features:	10-cps print speed; standard interchangeable daisy-wheel print element and ribbon

Display
Attaches to a standard color or black-and-white television; 256 by 192 display resolution (maximum); 36 characters by 24 lines in word-processor mode; 31 characters by 16 lines in SmartBASIC

Accessories
Two Colecovision joysticks with keypad; special holder to attach one joystick to the keyboard; all necessary cables and adapters; one blank preformatted digital data pack (cassette)

Software
Internal Smartwriter word processor; SmartBASIC (partly Applesoft compatible); Buck Rogers Planet of Zoom arcade game (tape)

Documentation
Four manuals, all 6 by 9 inches: Set-Up, 64 pages; Smartwriter, 101 pages; SmartBASIC, 225 pages; Buck Rogers, 10 pages. Also includes card for free one-year subscription to Adam Family Computing magazine.

Price
$750

Peripherals
Scheduled for release this year: Adamlink 300/1200-bps modem, less than $250; 5¼-inch disk drive, less than $400; 64K-byte memory expansion, less than $200; accessory kit, including three print wheels, a blank digital data pack, a multistrike carbon ribbon, and a tape-head cleaner, all for about $40; printer tractor-feed option, $125

Audience
First-time computer buyers wanting a complete home computer system for less than $1000

Although the Adam's tape drive is uncomfortably slow compared with floppy-disk drives, it operates much faster than any standard cassette-tape drive. The 20-ips speed is far faster than a normal cassette speed of about 1⅞ ips and even faster than the 15-ips speed used for professional recordings.

The tape used in the Adam system, although similar in appearance to ordinary cassette tape, differs significantly from it. Several modifications have been made to the plastic cassette shell so that it is not possible to use a standard audiocassette in the Adam computer or place an Adam digital data pack into an ordinary cassette recorder. Changes were also made to the tape media, according to Coleco.

When using the Adam data packs, you must take care to be sure they are properly seated in the drive. There is no built-in guiding mechanism to help do this.

Backups Are a Problem

The standard Adam comes with one tape drive and room for a second one. But even if you have two drives, it isn't any easier to make backups, because the operating system does not have a COPY or a BACKUP command. This can be a serious problem, particularly because SmartBASIC resides on tape and Coleco provides only one copy of it. If humans and computers were perfect, one copy would be sufficient. Because neither is, the inevitable is bound to happen: an important program, or even SmartBASIC, could be lost.

Twice, the SmartBASIC file on my tape was somehow damaged. Coleco suggested that it may have been my fault and that the tape may have been damaged by the machine's magnetic field (see "Two Tales of Adam" on page 212). I think not, but in any case it took several phone calls and a week and a half to get a replacement. It's apparently a new version. The BASIC filename no longer appears in the catalog, but it loads properly.

When benchmark programs were run to see how long it would take to write and read a 64K-byte file to tape, three different data packs caused the Write program to terminate with an I/O (input/output) error (see "Benchmarking SmartBASIC," page 214). A fourth data pack permitted the 64K-byte file to be written to tape, but the file could not be read due to more I/O errors; this problem is most disturbing because there is no warning that the data written out to tape is unreadable.

[**Editor's note:** *Coleco has said that a large number of tape problems have occurred because consumers leave tapes on an Adam peripheral or in the drive while turning the machine on or off. However, even tapes handled exactly as Coleco suggests rapidly lose capacity due to problems in allocating file space; deleting a file does not necessarily free up the tape space it used. Coleco has recommended using the BASIC INIT command to reformat a blank tape. The INIT command should not be used on the BASIC tape because it erases all the information on a tape, including the SmartBASIC software and all the program and text files. . . .* **M.W.**]

Coleco has indicated that it plans to come out with a utility data pack containing both a Copy program and a program for initializing (or formatting) blank data packs. Blank data packs weren't available at the time of this review; Coleco said they should be on the market (at a price of less than $8) by the time this article is published. The tapes are roughly the length of a C-60 cassette and store 255K bytes of data. Coleco said the Adam tape system can handle longer tapes to store a half-megabyte of data, but those tapes are not yet available.

Photo 2: *The Adam's 64K bytes of user memory and 16K bytes of video memory, plus the 255K-byte tape drive, enable use of more advanced entertainment software than Coleco's game system. Shown here is a scene from the Buck Rogers game that's included with the machine.*

A Complete System

Perhaps the Adam's strongest selling point is the fact that it is a complete system. The price even includes a letter-quality daisy-wheel printer. Computer snobs quickly will point out that the printer is slow, capable of printing only about 10 characters per second (cps), and they're correct: it is slow. But I don't consider speed an important issue with the Adam.

I'm not against fast printers—frankly, I prefer them—but for the newcomer to computing who's going to use the machine for programming and word-processing applications, a 10-cps daisy-wheel printer is a darn good compromise. It would have been nice if Coleco had used a standard printer interface on the computer so that those who want to could use higher-speed printers. The company has indicated that a serial printer interface may be available later.

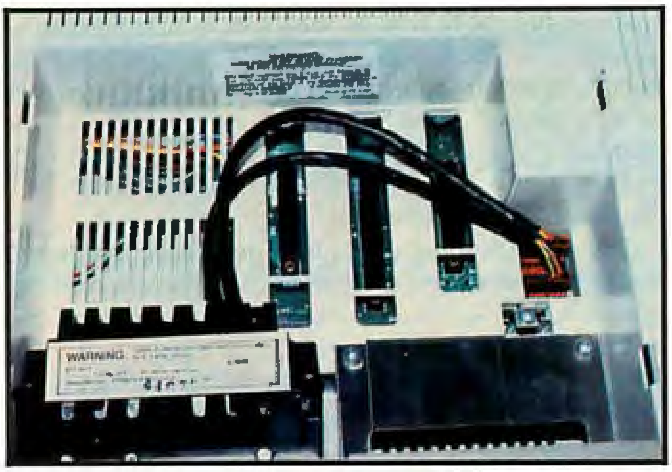

Photo 3: *Three expansion slots reside under a removable top panel. Also visible is the digital data pack (cassette tape) drive and room for an optional second tape drive.*

The daisy wheel used in the Adam printer is a standard 96-character plastic wheel, and the ribbon is a standard Diablo Hytype I or Xerox 800. The printer is capable of both superscripting and subscripting (from the word-processor mode) but cannot print in boldface. I had a number of problems with three different printers; despite Coleco's best efforts, I still don't have one that works.

Coleco's literature indicates that the printer is bidirectional, but this is true only in the word-processor mode. In BASIC, the printer prints in one direction only.

Three cheers for Coleco's keyboard! The company's engineers, when designing this low-cost home computer, were smart enough to realize that the keyboard was not the place to save money. The keyboard on the Adam has 75 full-travel keys arranged in a standard typewriter configuration, including six special word-processing keys, six programmable function keys, and five cursor-control keys (see photo 4). The keyboard is attached to the main console via a coiled cable that has standard modular tele-

Photo 4: *The Adam's detachable keyboard, perhaps the best-designed part of the system, has 75 full-travel keys.*

Photo 5: *The Adam's word processor is built into the system's ROM chips. Although limited, the Smartwriter word processor should be adequate for home use.*

phone connectors on each end.

An additional 12 keys on the joystick controller can be used as a numeric entry pad while in word-processor mode. However, information on accessing the joystick and its keypad from BASIC was not included in the manual.

Built-In Word Processor

The Adam is more than just a personal computer. A full-fledged word processor is built into the machine (see photo 5). Unlike BASIC, which is stored on tape, the word-processing program is built into the system's ROM (read-only memory). The Adam's word processor is certainly suitable for home use, but it doesn't have all the capabilities demanded by a professional word-processing system.

The word processor is slow. It can keep up with even the speediest typist, but access to text entered in different sections of a document is slow. If you want to move from one part of a long document to another, the cursor-control keys permit movement either one line at a time or several lines at a time by pressing the arrow keys and the Home key together. Even this "fast" movement through text is agonizingly slow for someone used to professional word processors.

Although the word processor has some advanced features, such as subscript and superscript characters, it lacks others, such as boldface print or form-letter processing. It does not have a "what you see is what you get" type of display, so you never really know what your text is going to look like until you print it out. The display uses 36 characters per line. On the bottom of the screen is a graphic representation of a typewriter roller; across the top and the left side are horizontal and vertical margin markers, which are helpful because they give you an idea of where you're typing on a printed page.

The word processor was still not fully debugged when the first machines were shipped. When I decided to change the margins for text already entered, the computer reformatted the text and all seemed well. However, when I continued to enter text, the computer would sometimes refuse to recognize carriage returns and would continue entering text on the same line. Coleco said this bug was fixed, as were others, in the current version of the machine.

[**Editor's note:** *The word processor occasionally repositions the cursor to the beginning of text after some text insertions, requiring movement to the inserted line using cursor keys or the SEARCH command before continuing. Coleco called this a "nondestructive" bug because it does not damage text, and said it plans to fix it at a later date. . . .* **M.W.**]

Another annoying feature of the word processor is that in order to implement many of the functions, several keystrokes must first be executed. For example, to delete text

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Circle 181 on inquiry card.

Two Tales of Adam

The first time I used the Adam, the SmartBASIC cassette wouldn't even load. Supposing the tape was defective, I took it to the dealer for replacement, only to learn that Coleco wouldn't provide such spares. After quite a few phone calls and two trips, I managed to return my computer and buy another from another dealer.

This time, SmartBASIC loaded quickly; after several days, however, the SmartBASIC file vanished from the tape. A call to Coleco's consumer hotline resulted in a technical honcho suggesting that I probably left the tape on top of the printer or a television, thus erasing it. He then complained that people have less respect for tapes than for floppy disks. However, I don't think I did subject the tape to harm. An added curiosity: when SmartBASIC was erased—and it happened again another time—no other files were affected.

In any case, I was without BASIC; it was several phone calls and a week and a half later before I received a new tape.

The printer worked fine for the first two weeks, and then the daisy wheel started spinning like crazy. After I reset the machine, the printer no longer operated properly, printing different characters than the ones I typed. Coleco experts had no explanation but agreed to replace the printer.

Another phone call and two weeks later, a replacement arrived. It didn't work. Another call led to another printer. This time, the printer came with a piece of paper in it that had obviously been used to test the printer before it was shipped. The test showed plainly that the tops of some of the letters were missing—yet they shipped it anyway. Maybe someday I'll get a complete, working system. **—Jules Gilder**

I spent two days running the Adam computer through simple tests and benchmarks without experiencing a single problem. It was only when I tried to do useful work that the Adam showed problems.

I typed a long BASIC program into the machine and tried to save it to tape. After whirring for a few minutes, the Adam reported a "No More Room" error—although I was trying to save a file about 6000 characters long when the directory said I had 220 blocks (about 220,000 characters) free.

I learned that I could save shorter files, however, and thus saved half of my program. Later, the length of files I could save grew shorter and shorter until I could no longer tolerate it. I decided to write a letter to Coleco explaining the problems, planning to send the tapes for replacement as the company suggested on its consumer hotline (after putting me on hold for 45 minutes).

The word processor, for some reason, dropped a line of my letter while it was being printed. I corrected the letter; the word processor dropped a different line of text. The third time I tried, the printer locked up and wouldn't print. I couldn't save the letter to tape since the tape drive was the problem.

My dealer agreed to replace the main console and tapes, taking parts from a machine that had been returned because of a defective printer. Everything was fine for another week, and then the "No More Room" error reappeared. I knew I only had about 40K bytes saved to tape, so I checked the directory. This time, the directory said there were only 16 blocks free (I was trying to save a 22K-byte file). The tape had lost almost all of its 255K-byte capacity!

The word processor in my second machine also exhibited problems, this time replacing characters in my text at random during printing. After waiting three weeks for a replacement, I received a refund from my dealer. **—Mark Welch**

[**Editor's note:** *Coleco said that most of the aforementioned problems have been corrected in later versions of the Adam. However, "nondestructive" problems, such as repositioning the cursor after an insertion in the word processor, have not yet been corrected, Coleco noted. At press time, we were unable to test a newer machine. . . .* **M.W.**]

you must press the Delete key, move the cursor to the first character to be deleted, press the Hi-Lite function key, highlight the text to be deleted using the cursor keys, and finally press Final Delete.

SmartBASIC

SmartBASIC is not located in ROM but must be loaded from a digital data pack as described previously. Early purchasers of the Adam computer got one of several versions of SmartBASIC with bugs. BASIC wouldn't even load properly in the first machine I bought.

Other changes were made to SmartBASIC. To mimic Apple's DOS 3.3, one section of the tape is reserved for directory information. In early versions of the SmartBASIC tape, this information is stored at the beginning of the tape. Later versions have the data stored in the middle of the tape to cut down on the access time to any particular program. In early versions of SmartBASIC, the CHAIN command does not work.

If you're wondering which version of BASIC came with your computer, you've got a problem: despite the many changes to the language, all versions are labeled 1.0.

Although Coleco boasts that its SmartBASIC is compatible with Applesoft, there are a number of differences in the languages. SmartBASIC was not written by Microsoft, as was Applesoft, and does not have the same internal construction as Microsoft BASIC. A positive result of this difference is that new ideas in interpreter design were included. For example, SmartBASIC checks syntax on entry. SmartBASIC is also more highly table-driven than Microsoft BASIC, increasing the operating speed. SmartBASIC may be the fastest 8-bit BASIC around.

Another advantage of SmartBASIC not being written by Microsoft is that it doesn't have the bugs associated with Microsoft BASIC. The author of this language made sure that all floating-point numbers are properly represented, with no round-off errors occurring as with IBM's Microsoft BASIC.

The SmartBASIC interpreter's unusual way of storing

Text continued on page 216

Benchmarking SmartBASIC

At the time the Adam was introduced, Coleco claimed that its SmartBASIC was faster than Applesoft BASIC, with which it was to be compatible, and also that its digital data pack (cassette) drive would operate at "transfer rates comparable to floppy disks." As can be seen from BYTE's standard benchmark programs (see table 1), SmartBASIC is indeed faster than Applesoft at some operations, but a comparison of the mass-storage speeds shows that the Adam is much slower. A lack of compatibility is also apparent in running the benchmark programs.

The prime-number algorithm normally uses a 7000-element array (see listing 3), an acceptable value for the Apple and most computers with 64K bytes of RAM (random-access read/write memory). But the Adam, for reasons unknown, cannot dimension an array larger than 5112 elements. As a result, no direct comparison can be made for the prime-number benchmark. A version with 5000 elements shows the Adam to be much faster than the Apple, but the incompatibility should alert users to the possibility of other limitations in the Adam.

The Adam was also unable to run the standard Applesoft BASIC benchmarks to write and read a 64K-byte file (listing 2) because that program writes text data to a file as five hundred 128-character blocks. The Adam's SmartBASIC cannot accept a 128-character string as input (listing 2b, line 180), and thus it could not run the program using the file written by listing 2a. A new program, writing a 64K-byte file as one thousand 64-character lines, was used (listing 1). As the table shows, it takes the Adam about nine minutes to access the 64K-byte file, compared to Applesoft's three minutes. (Note that Applesoft is already slow compared to the 32-second run-time for the IBM Personal Computer.)

—Mark Welch

Listing 1: *The 64K-byte file disk/tape Write and Read programs used to compare SmartBASIC and Applesoft (see table 1).*

(1a)

```
5 nr = 1000
6 a$ = "1234567812345678"
7 b$ = a$+a$+a$+a$
10 d$ = CHR$(4): REM Control-D
15 PRINT "opening file"
20 PRINT d$; "OPEN TEST"
30 PRINT d$; "WRITE TEST"
40 FOR i = 1 TO nr
42 PRINT b$
44 NEXT i
50 PRINT d$; "CLOSE HELLO"
55 PRINT " done"
59 END
```

(1b)

```
5 nr = 1000
10 d$ = CHR$(4): REM Control-D
15 PRINT "opening file"
20 PRINT d$; "OPEN TEST"
30 PRINT d$; "READ TEST"
40 FOR i = 1 TO nr
42 INPUT c$
44 NEXT i
50 PRINT d$; "CLOSE HELLO"
55 PRINT " done"
59 END
```

Listing 2: *The 64K-byte file disk Write (2a) and Read (2b) programs normally used as benchmarks for the Apple II Plus. The Adam cannot accept the 128-character string during line 180 in listing 2b.*

(2a)

```
  5 D$ = "": REM CONTROL-D
 40 A$ = "12345678123456781234567812345678"
 60 B$ = A$ + A$ + A$ + A$
 80 NR = 500
100 PRINT D$"OPEN TEST"
120 PRINT D$"WRITE TEST"
140 FOR I = 1 TO NR
180 PRINT B$
200 NEXT I
220 PRINT D$"CLOSE"
240 PRINT "DONE"
```

(2b)

```
  5 D$ = "": REM CONTROL-D
 80 NR = 500
100 PRINT D$"OPEN TEST"
120 PRINT D$"READ TEST"
140 FOR I = 1 TO NR
180 INPUT B$
200 NEXT I
220 PRINT D$"CLOSE"
240 PRINT "DONE"
```

Listing 3: *The standard prime-number program used as a benchmark. To run on the Adam, lines 1 and 2 had to be changed to reflect a limit of 5112 elements to an array. For the benchmark listing, the values of 7000 and 7001 were replaced with 5000 and 5001.*

```
 1 SIZE = 7000
 2 DIM FLAGS(7001)
 3 PRINT "only 1 iteration"
 5 COUNT = 0
 6 FOR I = 1 TO SIZE
 7 FLAGS(I) = 1
 8 NEXT I
 9 FOR I = 0 TO SIZE
10 IF FLAGS(I)=0 THEN 18
11 PRIME = I+I+3
12 K=I+PRIME
13 IF K>SIZE THEN 17
14 FLAGS(K)=0
15 K=K+PRIME
16 GOTO 13
17 COUNT = COUNT + 1
18 NEXT I
19 PRINT COUNT, " primes"
```

Benchmark	Adam SmartBASIC	Applesoft BASIC
Empty FOR. . .NEXT loop	5.5	6.66
Division	50.0	29.0
Subroutine jump	11.1	13.9
MID$(substring)	20.7	32.3
Prime number (7000 elements)	(error)	190.0
Prime number (5000 elements)	78.0	170.0
64K-byte tape/disk write (listing 1a)	564.0	200.0
64K-byte tape/disk read (listing 1b)	527.0	214.0
64K-byte disk write (listing 2a)	(error)	175.0
64K-byte disk read (listing 2b)	(error)	217.0

Table 1: *The timings of Adam SmartBASIC and Apple II Plus Applesoft BASIC using seven BASIC benchmark programs. The listings for the first five programs appear on page 54 of "A Closer Look at the IBM Personal Computer" (January 1982 BYTE, page 36). The disk/tape read and write programs are reproduced in listings 1 and 2. Adam was unable to dimension a 7000-element array and so a smaller (5000-element) array was tested on both the Adam and the Apple II Plus.*

Coleco's Third-Party Software License

Software developers seeking technical information are required to sign Coleco's Technology Licensing Agreement before Coleco will reveal the information needed to write anything more complex than a simple SmartBASIC program. But the agreement represents an exacting toll to software developers.

First, Coleco demands the right to inspect samples of any program before the developer distributes it. If Coleco isn't satisfied with the program's quality, the developer must change it as Coleco requests or lose the software license. If Coleco does terminate the license, the software developer must cease manufacturing all programs licensed under the agreement.

If a problem in quality control was the reason for terminating the agreement, the developer must send Coleco the remaining inventory. Otherwise, the developer must provide a list of the complete inventory and dispose of excess stock within 90 days. Coleco also demands the right to perform a physical inventory to verify the developer's claims. If the developer doesn't permit the inventory, Coleco claims the right to remove all remaining inventory by entering the storage location, without any liability for damage.

Coleco licensees must also mention the Adam in advertising and provide booth space for Adam products at trade shows.

Perhaps the most restrictive clause in the agreement is this one: "Licensee agrees that it will not, during the term hereof, make or cause to be made disparaging or critical references to the quality of Coleco's products and/or Coleco's business methods." In essence, developers cannot talk critically about Coleco's products or practices.

Text continued from page 212:
program lines in memory was less understandable to me. Program lines don't have the familiar Microsoft line structure (2 bytes point to the next line, 2 bytes for the line number, a tokenized line, and a 0 as a line terminator). In SmartBASIC, the line numbers and next-line pointers are stored in separate tables elsewhere in memory.

The SmartBASIC manual is a classic example of how not to produce a manual. Coleco has indicated it is painfully aware of the deficiencies and said a new manual is being prepared.

Microsoft BASIC stores lines in memory in numerical order, moving segments of the program up and down as lines are added and deleted. SmartBASIC stores lines as they are entered: if line 100 is entered first and line 10 second, they are stored in memory in that order. This doesn't cause problems when the program is listed because the next-line pointer table is properly maintained.

Incompatibilities extend beyond the internal structure of the language. Some tape-based commands are lacking, and other commands (such as FLASH, by which characters are made to flash between inverse and normal) are not provided on early versions of the machine. Most of the other Applesoft commands have been implemented, but early buyers of the Adam are not going to be able to use them because the proper documentation is not included. For example, shape tables and DRAW and XDRAW commands are mentioned several times in the current manual under definitions of other commands but are not themselves explained. Coleco said they are covered in the new manual.

Another annoying feature of SmartBASIC is that it requires spaces between keywords, as do later versions of Microsoft BASIC. Applesoft is very tolerant of this sort of thing and is smart enough to recognize most keywords without spaces.

Although most of the Applesoft commands are available in SmartBASIC, many Applesoft programs may not run as is because of hardware differences. For example, Applesoft uses four memory locations to control the borders of the active screen window so that only certain portions of it are scrolled or modified. SmartBASIC does not have this windowing capability. Also, some Applesoft programs read the keyboard directly by looking at a particular memory location to see what key has been pressed. Coleco's manuals do not include this information for the Adam, which uses different locations. And, as previously mentioned, Applesoft programs that directly access the Apple's memory-mapped display will not run on the Adam without major changes.

Another difference between the Apple II and the Adam relates to their display size. The Apple displays 40 characters per line. The Adam, however, has a 36-character display in the word-processing mode and a 31-character display in BASIC. The difference causes some display problems.

SmartBASIC's HGR routine has a bug in it: if you try to draw a box along the outer borders of the HGR screen (0,0 to 0,255 to 159,255 to 159,0 to 0,0), a triangle is drawn instead. If you switch to HGR2, the program works fine.

Coleco said it is planning to come out with an improved version of the language, fully integrated with the word processor to provide sophisticated editing capabilities (BASIC programs can now be edited with the word processor only by resetting the machine). Although it is also working on implementing other languages, including Logo, Coleco said it will always support BASIC.

How Not to Produce a Manual

The SmartBASIC manual is a classic example of how not to produce a manual. It appears as if it were rushed out the door with little thought given to its composition, completeness, or accuracy. I've been involved with personal computers ever since the KIM-1, so I've seen a lot of manuals, good and bad. The BASIC manual that comes with the Adam, however, is the worst I have ever seen. The book is full of typographical errors, programming errors, and misleading statements. In addition, it is incomplete: there are roughly 30 SmartBASIC commands that are not documented.

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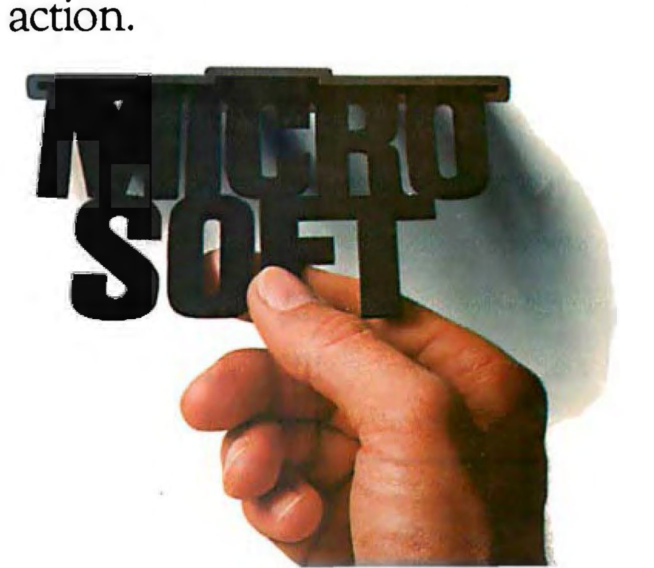

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The BASIC manual is typewritten, or printed on a computer printer (not the Adam's), which means that one typeface dominates throughout the book; boldface is used for emphasis. No illustrations or color are used; it's a very dull graphic presentation. (The other manuals included with the system do use graphics and photos.)

For now, Coleco's customer-service people suggest Adam owners buy an Applesoft BASIC manual.

The table of contents covers only the first 131 of the book's 222 pages and does this with only four brief entries. No mention is made of the reference section, where each command (except for the 30 undocumented ones) is explained. There is no index.

The situation is aggravated even further by the fact that there is no delineation in the manual between operating-system commands and BASIC commands. For example, the manual's authors combine the BASIC DEL command and the operating system's DELETE command into a single misleading definition: "The DEL or DELETE command may be used to erase a single line, a sequence of consecutive lines, an entire program or an entire data file." The manual gives an example of the DEL command by listing a four-line program whose line numbers are 10, 20, 30, and 40. Lines 20 through 40 are deleted, the book says, by entering "DEL 15,40" —in this case, the DEL command is used to delete a range of lines that begins with a nonexistent line number. Although this works, there is no explanation of *how*. Novice users are left to figure out for themselves, if they can, how the DELETE command works and what it is used for.

An example of misinformation occurs on the next page of the manual: you are told that it is only possible to have one- , two- , or three-dimensional arrays; a quick test, however, shows that much larger multidimensional arrays are possible, probably up to 255, as is the case with most BASICs.

The manual includes two blue pages full of corrections to be marked by the buyer onto the appropriate pages, but not all the bugs are corrected. For example, the sample program listed with the HGR and HGR2 commands to draw a rectangle on the high-resolution screen was obviously not tested—a line was missing. (The missing line is: 35 HPLOT 100,10 TO 100,100.) Without this line, the program draws only three sides of a rectangle. The manual also states that the resolution increases from 256 by 160 picture elements (pixels) in HGR to 280 by 192 pixels with HGR2; actually, the resolution for HGR2 is 256 by 192 pixels.

Coleco has indicated that it is painfully aware of the deficiencies of the original BASIC manual and that a new one is being prepared. It should be out by the time this issue is published. In the meantime, Coleco's customer-

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service people suggest that Adam owners buy an Applesoft BASIC manual.

Replacements, Peripherals, and Accessories

Early purchasers of the Adam are stuck with what comes in the original package. Dealers have not been provided with spares or backups of any element of the package, and additional game tapes or even blank tapes were not available at the time of this review. But the manufacturer said it is planning on making a variety of accessories available. A 64K-byte RAM expansion kit will reportedly sell for less than $200.

Coleco announced that it will offer a double-sided, double-density 5¼-inch disk drive, Personal CP/M, and an 80-column expansion board for less than $400; the products are scheduled for release by June. Extra tape drives will be available soon for less than $200 each. (Tape duplicators have said that Coleco's high-speed tape is not easy to duplicate, and at least one major software manufacturer has indicated that it's heard that Coleco is switching to disk drives. Time will tell.) Coleco has also announced a 300/1200-bps modem, priced less than $250, that should be available by early summer.

Third-Party Software

With a very large potential customer base for the Adam, it's not surprising that many third-party software firms are interested in producing software for the machine. But unless Coleco changes its attitude toward third-party vendors, it may suffer the same problems that befell Texas Instruments when it tried to control all software produced for the TI 99/4A.

Al Kahn, Coleco's vice president, has indicated in no uncertain terms that the Adam's creator does not intend to make the same mistake that Texas Instruments did and will support all third-party vendors of software, including those that wish to market their products by themselves. But Coleco is not revealing much technical information about the Adam and will not tell software developers anything about the operating system or the locations of subroutine entry points unless the developers are licensed by Coleco. Some of that technical information will be in the technical reference manual, which should be available in June; until then, however, the information will be available only to licensed software developers.

This policy will do little to spur the much-needed software support that will make or break the Adam. It was many small software companies, not a few large firms, that made computers like the Apple successful by providing thousands of applications programs. If Coleco doesn't change its policy soon, small software developers are likely to choose a less reluctant manufacturer's machine. In addition, many larger software companies may choose not to support the Adam because of the license restrictions Coleco imposes before divulging proprietary information. (See the text box on page 216 for a closer look at the third-party license.)

Adam owners may discover that Coleco's reluctance to reveal technical information is resulting in a limited number of software titles for their computers. However, a number of publishers, including Spinnaker, Infocom, Sierra On-Line, Broderbund, Human Engineered Software, and Activision, have announced software support for the Adam.

Reliability

The Adam computer's track record for reliability is terrible, if my experiences are an accurate indication. I have had four different systems in the space of two months and am waiting for my fifth. The printer is still not working. Other problems have centered around the operating system, the BASIC tape, and the tape drive. The only component that seems to be holding up well is the keyboard.

Coleco has claimed that reliability problems are low and within normal rates of occurrence. Considering that I've had four systems in two months and still haven't got one that's working satisfactorily, I find that hard to believe. [**Editor's note:** *At press time, Coleco said most word-processing and tape-drive defects had been corrected, and that a revised, more informative manual would solve most of the other problems that have led to returns. . . .* **M.W.**]

Conclusions

Although the Adam is a machine with a lot of potential, much of it has yet to be realized. The computer was apparently rushed into production before it was completely debugged and, as I've indicated, it has a terrible record of reliability. Many corrections are being made to its documentation, and the BASIC that comes with the computer is being enhanced. These corrections and enhancements, as well as what promises to be a broad range of peripherals and accessories, are scheduled to appear later this year.

Bearing all of this in mind, the best recommendation I can make is don't buy an Adam—yet. Wait until Coleco fixes all of the Adam's bugs and delivers on all of its promises. More than one company has entered the home computer market with great fanfare and plans for the future, only to drop out of the market and leave its early supporters stranded high and dry. Mattel is a good example of this. It promised a wide variety of peripherals and CP/M compatibility for its Aquarius computer, but now it is out of the home computer business; people who bought the Aquarius are stuck with a machine that has no support and no future.

I'm not saying this will happen with Coleco, but it could. Recent articles in the financial press hinted that Coleco is betting the whole company on the Adam and it's not yet clear that it's going to win that bet. ■

Jules H. Gilder (RD2, Box 475, Monticello, NY 12701) is a former editor of Personal Computing *magazine and the* Microcomputer Software Letter. *He has just finished writing his eighth book,* The Executive's Guide to Integrated Software.

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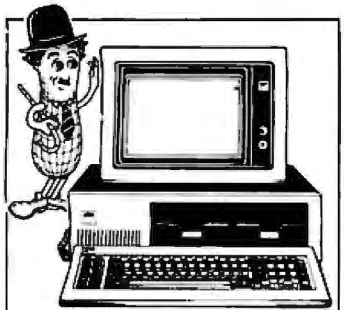

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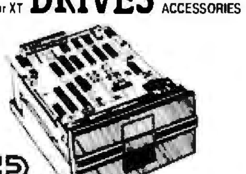

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Micro-Logic

A simple way to design digital circuits with your Apple II or IBM PC

Richard Krajewski
BYTE Technical Editor

Until now, microcomputers have been in a rut. They've been used for word processing, spreadsheets, and games, period. Sure, there have been occasional oddball uses, such as controlling your coffeepot, but there haven't been any new applications for which we could say, "Yep, the microcomputer is the only way to do that now." And that's a shame, because the microcomputer can be very versatile.

Now there is a new and limitlessly practical application for the microcomputer—the design of digital circuits. Minicomputers and mainframes have been designing digital circuits for a long time, but the application has only recently become widely available for the microcomputer. A digital-design program may be of limited interest to the average computerist, but for those thousands and thousands of engineers who are chained to paper, pencil, and template, a microcomputer-aided design system is too good to pass up.

Micro-Logic is a good example of a digital-design program for the microcomputer. The program lets you design and test hypothetical digital circuits on your Apple II or IBM Personal Computer. It has two parts: the designer module and the analyzer module.

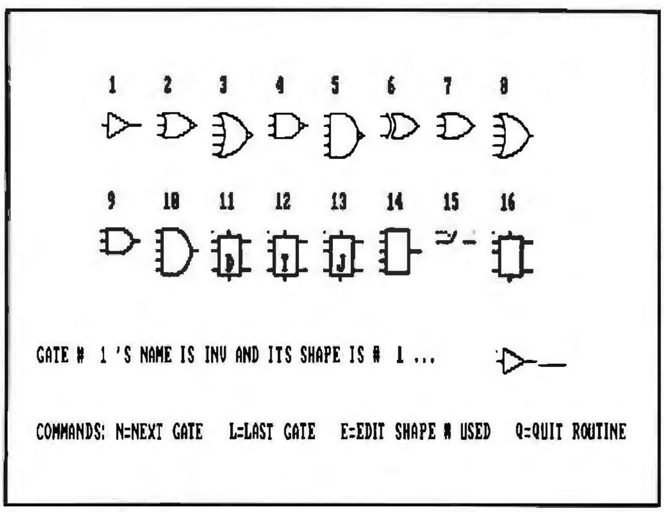

Figure 1: *The logic component shapes available for use in Micro-Logic.*

The Designer Module

The designer module lets you draw the digital logic circuits. When you call the module from the main menu, you get another menu that lets you 1) erase old designs, 2) begin designing, 3) change or add digital component shapes, or 4) return to the main menu. The first choice erases files produced from the previous design session. The second choice lets you begin drawing a new circuit or change an old one. The third choice lets you change or add component shapes, but it does not let you define the function of the components; you do that with the analyzer module. Figure 1 shows the shapes that are provided with Micro-Logic.

Drawing a circuit with the designer module is easy. If you want an inverter, you just type A for add and INV for inverter. For an AND gate with three inputs, you type A for add and AND3 for the AND gate. (By the way, the gates have only one orientation—input from left, output on right.) To draw a line from one gate to another, you press C for connect and the proper combination of direction keys to bring the line from the output of one device to the input of another.

Quitting the designer module presents a problem. You can quit only by typing Q, which not only ends the designer module but saves the design you've been working on. You should also be able to quit without saving the design. If you've found that you don't need the circuit you've been working on, you have to either erase every line one at a time or save the file containing the design and then erase it. You can't erase a file while you are using the designer module, either. For that, you need to use the analyzer module. There's also no way to rename a circuit-design file; all designs must use the same name. The only way to keep things separate is to use a different data disk for each design.

Notice that the designer module doesn't really do any designing. You do that yourself. You must specify the Boolean expression of the circuit, minimize it yourself with the Karnaugh map, and then draw it on the computer screen. The big advantage of the designer module is that you can draw the circuit quickly and, more important, test it later with the analyzer module.

The Analyzer Module

This module is the more complicated of the two. When you call it from the main menu, you see a menu that lets you select 1) the network editor, 2) disk operations, 3) the simulation program, 4) utilities, 5) the test-pattern editor, 6) the gate library, 7) the clock library, or 8) the main menu.

The network editor lets you call up the "netlist" that is generated by the designer module for a circuit that you have designed, or it lets you create your own netlist without a corresponding circuit. A netlist is a list of circuit components and their interconnections (see figure 2). Micro-Logic uses a netlist rather than the circuit graphics for testing and simulation. Actually, you don't even need to draw a circuit—you can type in a netlist instead and get the same results. However, you will probably find it easier to use the designer module to generate the netlist, especially when you are designing a complex circuit.

The disk-operations option lets you save or retrieve a network, delete files, and view the disk directory. The simulation option shows the timing pattern at every node of the circuit that you have loaded into memory along with the clock pattern and input patterns that you have also loaded into memory. The utilities option lets you select 1) the nodes to be monitored in the timing simulation, 2) a fan-out report, 3) simulation files for comparison, or 4) macros to be mapped into gates. (A macro, to Micro-Logic, is a circuit that is treated as a single gate. To create a macro, you draw the circuit and "map" it onto one of the logic component shapes. This way, you can create integrated circuits.)

The test-pattern editor lets you create input data for simulation runs on your circuit. The gate and clock libraries contain the truth tables of the logic gates and the waveform patterns of the clock. You can change the truth tables as well as the clock waveform patterns.

At a Glance

Name
Micro-Logic

Type
Logic design and simulation system

Manufacturer
Spectrum Software
690 West Fremont Ave.
Sunnyvale, CA 94087
Technical-support hot line: (408) 738-4387

Format
Three 5¼-inch disks

Language
Machine language

Computer
Apple II or IBM Personal Computer with 128K bytes of memory and two disk drives

Documentation
About 150 pages, 8½ by 11 inches, in a three-ring binder

Price
$475

Audience
Electronics engineers, technicians, and electronics instructors

A Typical Design Session

After you've made backup copies of the Spectrum Software disks and placed a copy of PC-DOS or Apple DOS on the program disk, you are ready to design a circuit. When you boot up, the first thing you see is the main menu. The menu lets you choose between the designer module and the analyzer module. It also gives you the option of making a new data disk or ending the Micro-Logic program.

You choose the designer module to draw your circuit, which you have already specified by either Boolean equation or rough sketch. When the designer module begins, you just call for the logic gates that you need and make the proper connections between them. You're not limited to one screen, by the way, but to nine screens that are interconnected. When you're done, you press Q to save the design and return to the main menu. Figure 3 shows a circuit prepared with Micro-Logic.

You can now analyze your circuit by choosing the analyzer option. Once in the analyzer menu, you select the disk-operations option, which lets you load the network that you generated with the designer module into memory. Your design will require an input, so you can choose one from the test-pattern editor. Figure 4 shows

SIMFILE NETWORK

NO.	NAME	LABEL	A	B	C	D	E	F	G	H
1	DATA 1	DATA	0	0	0	0	0			
2	PHASE 1	CLOCK	0	0	0	0	0			
3	INV	DBAR	1	0	0	0	0			
4	AND3		2	2	3	0	0			
5	NOR3	QBAR	0	4	7	0	0			
6	AND3		2	2	1	0	0			
7	NOR3	Q	5	6	0	0	0			

Figure 2: *The netlist of the circuit in figure 3 as it appears on the screen. The items under the column labeled NAME are the logic devices, input data channel, and clock. The lettered columns show to which device the inputs of a device are connected. For instance, one of device 4's inputs is connected to device 2.*

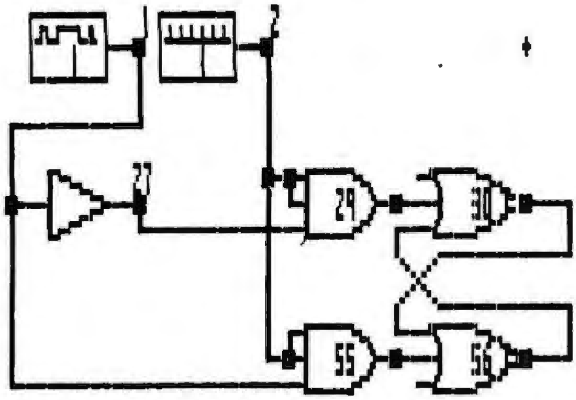

Figure 3: *A digital logic circuit prepared with Micro-Logic. The names and labels of each of the devices are shown not on the diagram but on the netlist. The numbers shown are the grid numbers of the screen and have nothing to do with the function of the circuit.*

(4a)

SIMFILE
Page 0 Clock Times

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
DATA 1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
DATA 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DATA 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DATA 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DATA 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DATA 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DATA 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DATA 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DATA 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DATA 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DATA 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DATA 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DATA 13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DATA 14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DATA 15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DATA 16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DATA 17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DATA 18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

UP DOWN RIGHT LEFT JUMP EDIT PRINT *RANDOM BINARY SET QUIT

(4b)

CLOCK SUB-CYCLE TIME

#	NAME	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	PHASE 0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	PHASE 1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
3	PHASE 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	PHASE 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	PHASE 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	PHASE 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	PHASE 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	PHASE 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	PHASE 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	PHASE 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

COMMAND MENU: L=LEFT R=RIGHT E=EDIT P=PRINT Q=QUIT

Figure 4: *The input patterns used for the circuit in figure 3. The DATA 1 bit pattern in 4a was used as the data input to the circuit. The PHASE 1 bit pattern in 4b was used as the clock for the circuit. Other data and clock patterns can be created with the Edit function.*

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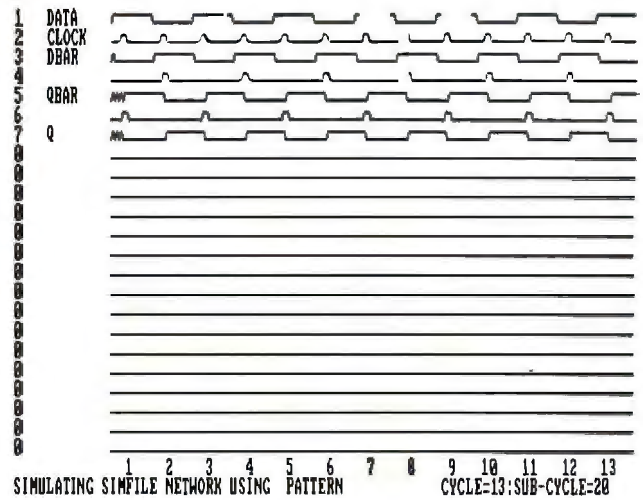

Figure 5: *The timing simulation for the circuit in figure 3.*

the pattern that I used in the simulation of the circuit in figure 3. When that's done, you can select a waveform for the clock signal.

Next, you have to decide how long the simulation will last and whether you want your design to be "compacted." You specify time in the simulation with clock cycles. For instance, you can run a simulation for 20 clock cycles. Compacting cleans up the netlist that the designer module created for your design. The designer module typically assigns two or three times more nodes than are needed at first because it assigns a node designation for every connection you make. Compacting discovers these faults. Unfortunately, it does nothing to make your design work better or with fewer parts; in other words, it does not minimize your circuit as you would with a Karnaugh map.

Figure 5 shows the timing simulation for our circuit. You can print out the simulation with the print-screen option if you are using an IBM PC. The beauty of this technique is that you can try several circuits without building a single one and obtain the timing information much more quickly than if you were to actually build the circuit and test the timing yourself.

If the simulation reveals a timing problem, you can obtain a fan-out report to see if you are connecting too many lines to the output of one device, which would cause an extra delay in that device. In fact, you can vary the delay of each device so that it matches the delay you would expect in the real world. You can also specify a variable delay that is a function of the fan-out of the device. Figure 6 shows the specifications for an AND gate that includes the delay.

Problems

Micro-Logic's biggest problem is its documentation. The manual is so difficult to read and so poorly organized that it is an outright obstacle to learning the system. For $475, you might expect a professionally prepared manual; instead, the Micro-Logic manual is right off the author's typewriter, with those really w-i-d-e blocks of text so typical of amateur documentation. The

(6a)

```
                                    INPUT STATES
       PIN 1 0101010101010101010101010101010101010101010101010101010101010101
       PIN 2 0011001100110011001100110011001100110011001100110011001100110011
       PIN 3 0000111100001111000011110000111100001111000011110000111100001111
       PIN 4 0000000011111111000000001111111100000000111111110000000011111111
       PIN 5 0000000000000000111111111111111100000000000000001111111111111111
       LAST..0000000000000000000000000000000011111111111111111111111111111111

NO. NAME                OUTPUT STATE TRUTH TABLE FOR ABOVE INPUT STATE

  1 INV          1010101010101010101010101010101010101010101010101010101010101010
  2 NOR3         1000000010000000100000001000000010000000100000001000000010000000
  3 NOR5         1000000000000000000000000000000010000000000000000000000000000000
  4 NAND3        1111111011111110111111101111111011111110111111101111111011111110
  5 NAND5        1111111111111111111111111111111011111111111111111111111111111110
  6 EX-OR        0110011001100110011001100110011001100110011001100110011001100110
  7 OR3          0111111101111111011111110111111101111111011111110111111101111111
  8 OR5          0111111111111111111111111111111101111111111111111111111111111111
  9 AND3         0000000100000001000000010000000100000001000000010000000100000001
 10 AND5         0000000000000000000000000000000100000000000000000000000000000001
 11 DFFTTL       0101010101010101010101010101010101010101010101010101010101010101
 12 TFFTTL       0101010101010101010101010101010110101010101010101010101010101010
COMMAND MENU: U=UP D=DOWN E=EDIT C=COPY P=PRINT Q=QUIT
```

(6b)

		DELAY		DEFAULT CLOCKS		OR PIN	CLOCK SAMPLING METHOD FOR PINS					
NO.	NAME	FIX	VAR	IN	OUT	#	1	2	3	4	5	OUT
1	INV	1	1	0	0	0	0	0	0	0	0	0
2	NOR3	1	1	0	0	0	0	0	0	0	0	0
3	NOR5	1	1	0	0	0	0	0	0	0	0	0
4	NAND3	1	1	0	0	0	0	0	0	0	0	0
5	NAND5	1	1	0	0	0	0	0	0	0	0	0
6	EX-OR	1	1	0	0	0	0	0	0	0	0	0
7	OR3	1	1	0	0	0	0	0	0	0	0	0
8	OR5	1	1	0	0	0	0	0	0	0	0	0
9	AND3	1	1	0	0	0	0	0	0	0	0	0
10	AND5	1	1	0	0	0	0	0	0	0	0	0
11	DFFTTL	3	2	0	0	2	2	0	2	2	2	2
12	TFFTTL	1	1	0	0	2	2	0	2	2	2	2
13	JKTTL	1	1	0	0	2	2	0	2	0	0	2
14	BLANK	1	1	0	0	0	0	0	0	0	0	0
15	TGATE	1	1	0	0	0	0	0	0	0	0	0
16	DFFMOS	1	1	1	2	0	2	2	2	2	2	1
17	TFFMOS	1	1	1	2	0	2	2	2	2	2	1
18	JKMOS	1	1	1	2	0	2	2	2	2	2	1

COMMAND MENU: U=UP D=DOWN E=EDIT C=COPY P=PRINT Q=QUIT

Figure 6: *The logic-gate specifications: the truth table (6a) and the characteristics table including the device delay (6b).*

margins are so wide that I often couldn't find the beginning of the next line. Then there's the problem of the index: there isn't one, so forget about looking something up quickly. I realize that this is the problem you hear over and over again about software from small companies, but maybe we ought to complain over and over again until they get it right. I hope that the next edition of Micro-Logic will have a professionally written and typeset manual.

Another problem, albeit a very minor one, is that you cannot create a complete schematic with Micro-Logic. That is, you cannot include power-supply connections, capacitor noise bypasses, and so forth. Micro-Logic is strictly concerned with the logic array and nothing else. The supporting circuitry is pretty standard and simple for an engineer to do, and wasteful for the computer to do, so I can see why the author of Micro-Logic left it out. Just don't present a Micro-Logic-generated diagram to your technician for construction unless he knows how to design support circuitry. You'll still have to use an elec-

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tronics template to add the final details, and you'll still have to test the circuit layout for noise problems and unforeseen delay problems that the layout may cause. Speaking of layout, I may be asking for the world, but I wish Spectrum Software would make an add-on package that would create board layouts from information generated by Micro-Logic.

Finally, there are not enough help options in the menu. Could a single screen full of additional information take up too much room on a disk or take too much time to develop? Perhaps the author of Micro-Logic felt that "real engineers" don't use help options. I'm sure that's true—but only after they have learned the system. Please give us more help options next time, Spectrum.

Praises

If I were an engineer and I had the option of using Micro-Logic or my paper and pencil, would I use Micro-Logic? You're darned right I would. For an investment of $475, I would get neater diagrams in less time and, more important, I would be able to run simulations on the designs. Compare $475 to the price of a mainframe or a minicomputer design system, which could easily be in the $100,000 range, and you know you have a bargain. I grant you that the larger systems have superior features, such as board-layout optimization, but in a business where a design may require thousands or millions of dollars, Micro-Logic is a cost-effective compromise between features and cost.

The simulation feature should pay for the program the first few times you use it, because it saves you the trouble of having to build a prototype to test the circuit's timing. A disadvantage of prototypes is that you may not be able to tell if the timing problem is in the layout, the component itself, or somewhere else. Because Micro-Logic concentrates on component delay, you can break the design up into more manageable components and troubleshoot more easily.

In addition to being valuable to practicing electronics engineers, Micro-Logic should be an asset to electronics engineering schools, because it will give students hands-on design experience without the fuss of dealing with a large electronics parts inventory. The program should also be a useful tool to the electronics engineering professor, who can use it to demonstrate the operation of digital circuits.

Conclusion

Micro-Logic takes a while to learn, but it is worth the effort. It is an efficient design system that does what it is supposed to do at a reasonable price. It should prove to be very popular with electronics engineers, engineering schools, and professors. If Spectrum Software would spruce up the manual, include more help features, and add a way to quit the design module without saving the design, Micro-Logic would be worth even more. ■

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Statistical Software for Microcomputers

A comparative analysis of 24 packages

James Carpenter, U.S. Government; Dennis Deloria, U.S. Government; and David Morganstein, Westat Inc.

The expanding availability of low-cost computing equipment offers us the opportunity to perform complex statistical analyses without a mainframe computer. Unfortunately, few sources of information on the capabilities and limitations of the burgeoning list of statistical software are available.

Several years ago, Platt and Platt (see reference 5) compared the regression performance of four personal computer software packages. They proposed a number of characteristics for comparing different packages. More recently, Woodward and Elliott (see reference 9) sent questionnaires to software developers asking them about the characteristics of their packages. They made available a table on the information provided by 30 software developers. In the November 1983 BYTE, Lachenbruch presented the statistical accuracy of regression computations for four packages available for the Apple.

In this review, we first propose and define comparative features of importance in the selection of a statistical package for a personal computer. We then describe general characteristics of the hardware and operating-system requirements, documentation and ease of use, and the statistical options that you may expect to find.

We then compare the features of the 24 packages we examined. After this, we talk about statistical accuracy and compare results obtained using a common data set. The comparisons are based on previously tested and documented data sets used on larger computers for the purpose of assessing accuracy.

The packages fall into one of two categories. While many of the programs try to provide most of the computations needed for a wide range of statistical analyses, some of them have specific purposes. That is, they deal with a fairly small subset of statistical functions. These more specialized packages may, however, have features not found in other packages, or they may excel in their specialty. The Dynacomp program Parafit fits unknown parameters of nonlinear, user-supplied functions, an option few of the other packages have. Alternatively, STAN is an exceptional package for performing the analysis of linear models such as multiple regressions. While general-purpose packages provide answers to many other questions, only SYSTAT is as comprehensive in the area of linear models as STAN.

The packages differ in another important way. Most of them are self-contained: you buy one program. Others, such as SpeedSTAT and HSD, come in a series: you buy only those modules or programs that perform the functions you need. For the latter type, we have tried to obtain all the programs in the series to make our assessment. However, since you can purchase them individually, we have listed their capabilities separately in the tables that follow.

As you can imagine, we experienced some difficulty in judging the packages on the basis of their documentation and a small amount of hands-on experience. We welcome your comments on our evaluation criteria and hope that our effort makes it easier for you to decide if you need a statistical package and to select the proper one. If you have had some experience with other packages, please share it with us as we have begun a clearinghouse for the collation and dissemination of information.

Individual Packages

You can't do a comparison of software without describing the package from a user's point of view. While our tables contain a great deal of useful comparative information, many of the programs have special points worth mentioning. Several of the packages described below do not appear in our tables due to their unique characteristics. We include a description since they may be of interest to some readers.

ABSTAT: This easy-to-use general statistics package handled all our errors in stride; intelligible error messages were displayed. We were never rudely kicked out of the program or prevented from recovering. Help was always available (just type "?") in the form of a clear statement of what you should do next. You could back out of commands if you changed your mind by typing "!".

Its good data-management and data-processing capabilities are easy to use except for one bothersome requirement: you must specify the total number of variables while creating a data set, and it must be large enough to allow for additional variables you may need. If you exceed this number, you must create a larger, empty data set and transfer the old data. These operations are easy but should not be the responsibility of the user.

The statistics are of the type found in elementary textbooks. Unfortunately, the two-way ANOVA allows only one observation per cell. ANOVA and regression require different file organization—a fault the company says is high on its priority list for modification. It indicated to us that a new version should be out early in 1984.

AIDA: This is a general-purpose statistical package with a wide range of capabilities. One of its most novel features is a virtual-memory system that reads variables from the disk when they are not currently in memory. AIDA was one of the few programs that let you add your own routine (in BASIC) that can be called directly as an AIDA command. AIDA's greatest limitation is in its numeric range. Numbers are stored internally as 2-byte integers (i.e., have a range of only plus or minus 32,767). Another difficulty is the storage of each variable as an individual file with a filename that includes the number of cases in the file. You must specify the number of cases when initiating analysis with AIDA. This number is later used as part of the filename to access the data. If the number of cases given when starting the program does not match the filename, the file cannot be found. While a quick catalog of the disk reveals the number of cases allowing you to restart your analysis, this procedure is awkward. Another weak point of AIDA is that a separate utility program must be run to add cases to an existing variable.

A-Stat: This general-purpose package provides many of the most desirable statistical functions. It is modeled after P-Stat, the minicomputer package. It has easy-to-use case filtering to specify subsets of records for analysis. While it has no graphical capability, it includes an interface to the Appleplot graphics package. It is written in Applesoft BASIC, and the author has thoughtfully provided both source and compiled versions. The program has undergone improvements for many years; the most recent version, 83.1, includes menu selection to simplify use of its previous command-language-only operating style. Case processing is done one record at a time; cases are read from the disk using BASIC string-handling routines. While this access method permits substantial file sizes, it results in long process times, even when running the compiled version. The author suggests that the program can be run in a batch mode, leaving you free to do something else while the computations are completed.

Dynacomp: A series of four packages, the easy-to-use Dynacomp programs perform somewhat unique, though valuable, statistical functions. The Regression1 program fits a generalized version of a polynomial regression. A polynomial regression tries to estimate a dependent variable using an expression involving various powers of an independent variable. Regression1 extends this to powers of selected functions (e.g., logs, exponentials, etc.) of the independent variable. The second regression

ABSTAT
Anderson-Bell
POB 191
Canon City, CO 81212
(303) 275-1661

AIDA
Dr. David Lingwood
Action-Research Northwest
11442 Marine View Dr., SW
Seattle, WA 98146
(206) 241-1645

A-Stat 83.1
Gary Grandon
Rosen Grandon Associates
7807 Whittier St.
Tampa, FL 33617
(813) 985-4911

Dynacomp
Dynacomp Inc.
1427 Monroe Ave.
Rochester, NY 14618
(716) 442-8960

EDA (Exploratory Data Analysis)
Paul Velleman
Conduit
POB 388
Iowa City, IA 52244
(319) 353-5789

HSD Stats Plus, ANOVA II, and Regress II
Stephen Madigan
and Virginia Lawrence
Human Systems Dynamics
9249 Reseda Blvd.,
Suite 107
Northridge, CA 91324
(213) 993-8536

Introstat 2.2
Ideal Systems
POB 681
Fairfield, IA 52556
(515) 472-4507

Microstat
Jack Purdham
Ecosoft Inc.
5311 North Central
Indianapolis, IN 46220
(317) 283-8883

Micro-TSP
College Division
McGraw-Hill
Princeton Rd.
Hightstown, NJ 08520
(609) 426-5000

Number Cruncher
Jerry L. Hintze
865 East 400 North
Kaysville, UT 84037
(801) 546-0445

NWA Statpak
Northwest Analytical Inc.
1532 SW Morrison St.
Portland, OR 97205
(503) 224-7727

SAM
International Software
Box 160
Welwyn Garden City
Herts, England A18 6TQ

SpeedSTAT: Volume 1: Frequencies and Crosstabs; Volume 2: Regression and Correlation
Dennis LaRue
Softcorp International
229 Huber Village Blvd.
Westerville, OH 43081
(614) 267-3109
(800) 543-1350

SPS Version 3A.0 (Statistical Processing System)
Data Basic Inc.
102 South Main
Mount Pleasant, MI 48858
(517) 772-5055

STAN
David M. Allen
Statistical Consultants Inc.
Park Plaza Office Bldg.
462 East High St.
Lexington, KY 40508
(606) 252-3890

Statpac
Wallonick Associates
5624 Girard Ave. South
Minneapolis, MN 55419
(612) 866-9022

Statpro
Mark Imhof
and Steve Hewett
Wadsworth Electronic Publishing Company
20 Providence
Boston, MA 02116
(617) 423-0420

SYSTAT
Systat Inc.
1127 Asbury Ave.
Evanston, IL 60202
(312) 864-5670

The Winchendon Group:
ELF and ARIMA
3907 Lakota Rd.
POB 10114
Alexandria, VA 22310
(703) 960-2587

program, Parafit, lets you enter your own one-variable function and then estimates the unknown coefficients of the function. The third program is a fairly standard multiple-regression program that permits transformations of the independent variable. It permits a direct computation using all the independent variables provided or a stepwise version (labeled iterative) that adds an independent variable at each step and calculates the improvement in fit provided. The fourth program performs an analysis of variance. It allows for several models with as many as five factors. Unfortunately, all but the one-way model must be balanced designs, that is, they must have the same number of observations in each cell.

One general comment about each program is that the documentation is brief. While each manual includes a worked-out example, the most extensive manual contains only 16 pages, much of which covers background theory. We had no problem getting the programs to perform their analyses.

EDA: Exploratory Data Analysis is an idea based on concepts described by Tukey in his 1977 book of the same name. The package is an extension of a series of programs in both BASIC and FORTRAN published in a 1981 paperback book by Velleman and Hoaglin. Almost none of the statistical procedures in our tables are provided by this package, so it is not listed there. True to Tukey's philosophy, however, many of those statistical procedures have nonparametric counterparts in EDA. They are counterparts in the sense that they attempt to determine many of the same characteristics of a data set, but they do so using methods that are based on fewer assumptions, are more resistant to extreme values, and do not calculate significance tests. Their purpose is to present the "lay of the land" in a data set, not to examine precise hypotheses, hence the name exploratory. The other packages reviewed here are not based on EDA although some produce EDA-type graphics.

The EDA package provides nine statistical routines, including stem-and-leaf displays, letter-value displays, box plots, condensed *x-y* plots, resistant line computations, smoothing computations, coded tables, median Polish tables, and rootograms. In addition, it includes a few utility routines, such as data entry, editing, transformation, and file storage. The statistical concepts behind each routine are adequately described in the Velleman and Hoaglin book included with the disks. Operation of the program is described in a 13-page addendum. Although somewhat limited in scope, the package is easy to learn and can usefully perform the exploratory analyses for which it is intended, filling a unique niche among these packages.

HSD: A series of three programs, the HSD packages provide general descriptive statistics (Stats Plus), regression (HSD Regress II), and analysis of variance (ANOVA II) capabilities. We found Stats Plus difficult to use because of the confusion resulting from the use of two file types: random access and sequential. The user must remember that certain statistical and data-handling functions require a certain file type. For example, ANOVA requires sequential files; cross tabulation requires random access; single data items cannot be deleted in sequential files; transformation errors are handled differently for each file type; data items are truncated during both keyboard input and transformations if the user-specified field width is exceeded for random-access files; and trailing blanks in search keys must be specified when searching random-access files.

In addition to the data-handling capabilities and high-resolution scatterplots of Stats Plus, Regress II features five regression procedures: simultaneous solution, forward solution, stepwise solution, backward solution, and polynomial regression. Regress II avoids the file-type confusion by using only random-access files for data. However, the user must still carefully plan the field widths of each variable entered or transformed.

ANOVA II shares the same data-handling capabilities of its sister packages while sticking with sequential files. The package features a mixed design capability—any combination of between-subjects and within-subjects factors up to a five-way ANOVA. Instead of using indicator variables to determine design cells, ANOVA II prompts for the data items in each cell. The user may either enter the data from the keyboard or specify a data file for each design cell.

Introstat 2.1: This package is targeted for people in the behavioral sciences, presumably because it makes special provision for case IDs. It is easy to use and does simple statistics. It has five different tests for significant differences among groups—we surmise that behavioral scientists want reassurance that their groups are really different!

This version uses only one disk drive. It is difficult to use with your data file on a disk other than the one that contains the programs since it does not indicate when to swap disks. Fortunately, the package is copyable and its code occupies less than half a disk (54K bytes), so plenty of room is available for several data sets of the size appropriate for this package (fewer than 3000 data items).

Although the entire data set is stored in RAM (random-access read/write memory) for fast manipulation, the data set must be read again each time a new option is selected from the main menu.

Microstat: This package was an enigma to us. On one hand it was a full-featured package with most of the desirable features one might wish for in a statistical package for professional use. On the other hand, we all had difficulty getting it to run without crashing at awkward times. Part of the difficulty was encountered in the installation procedure. Some of the installation parameters were not described in the manual (e.g., printer device number), and it crashed with the wrong number (0 worked). No error instructions or hints were given in the manual, and the cryptic screen comment was not helpful ("Out of bounds in line 1910"). Another part of the difficulty was the four levels of precision provided by the four BaZic interpreters included. A good feature of Microstat permits the user to make trade-offs between

Text continued on page 252

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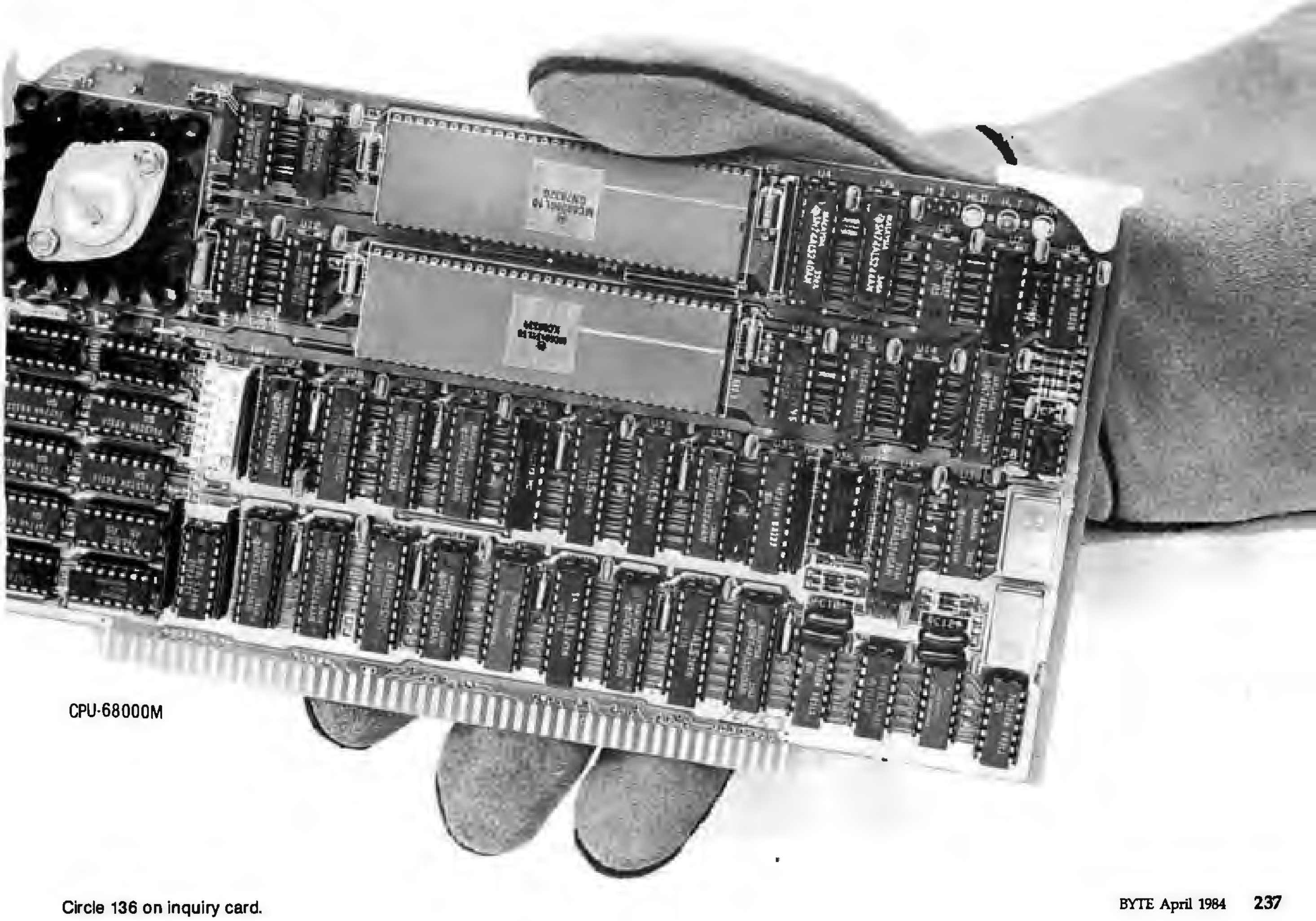

CPU-68000M

Circle 136 on inquiry card.

Interpreting the Tables

We found ourselves repeatedly dividing the packages into broad categories on the basis of their general characteristics, such as operating-system and hardware requirements, their limitations and documentation, their data-management features, and the range of statistical functions they perform. Tables 1-12 compare our assessment of these features for the software packages examined.

The first two tables provide general information. In particular, table 1 lists all available versions for various computers or operating systems. Tables 2-12 contain information specific to the version we tested. Our results often depend upon the particular version examined (e.g., the amount of data that can be processed). With a few exceptions, the packages were tested on an Apple II with 64K bytes of memory and two disk drives.

The following symbols are used throughout the tables: slash (/) means or; comma (,) means and; dash (—) means no, none, or not available; Y means yes; and question mark (?) means unknown.

General Characteristics

Table 1 covers program requirements.

Operating System: *The packages examined operate on one of the following microcomputer operating systems: CP/M, UCSD Pascal, PC-DOS, or Apple DOS. The systems are coded as follows: 8 = CP/M-80, 6 = CP/M-86, U = UCSD Pascal, P = PC-DOS, and A = Apple DOS.*

RAM/Disk Drives: *Stating disk-drive requirements is complicated by the range of storage capacity and format. The common disk sizes are 5¼ and 8 inches. However, the capacity of different configurations (single- vs. double-sided; single- vs. double-density) varies. Before selecting a package, be sure that your hardware can access the available disk formats provided by the distributor. If the program is distributed in a protected form, you may not be able to use peripherals such as hard disks or RAM disks. Be sure that the distributed format can be read on your system (e.g., buying a program that runs under the CP/M operating system does not guarantee that your particular hardware can read any of the distributed formats).*

Additional Software Needed: *The table indicates if additional software is needed to operate the package. For example, one package requires the BaZic language, a variant of BASIC. Many programs written in and supplied in BASIC require an interpreter. We have noted the following software requirements: A = Applesoft BASIC, P = UCSD Pascal p-code interpreter (for software supplied in UCSD compiled Pascal), Z = BaZic, and M = Microsoft BASIC (provided on disk with some, but not all, machines running CP/M or PC-DOS).*

	Operating Systems[1]	RAM (K bytes), min[2]	Disk Drives[2]	Additional Software[3,2]	Price[4]
ABSTAT	8/6/P	56/128/128	2	—	$395
AIDA	A	48	1	A	$235
A-Stat	A/8/P	48/56/64	1	A	$200
Dynacomp Regr 1	A	48	1	A	$24
Dynacomp Regr 2	A	48	1	A	$24
Dynacomp Multilin	A	48	1	A	$29
Dynacomp ANOVA	A	48	1	A	$44
HSD Stats Plus	A	48	1	A	$200
HSD Regress II	A	48	1	A	$150
HSD ANOVA II	A	48	1	A	$150
Introstat	A/P/R	48/64/48	1	A/B/R	$125
Microstat	8/P	48/?	2	Z	$325
Micro-TSP	A/P	48/64	1	A/B	$295 A $395 I
Number Cruncher	8/6/P	56/?/?	1	B	$200
NWA Statpak	8/P/B	48/?/?	2	M/B	$495
SAM	A/8/6/P	48/56/?/?	2	A/M	$395
SpeedSTAT Vol. I	A	48	2	A	$249
SpeedSTAT Vol. II	A	48	2	A	$299
SPS	A/8/6/P	48/64/64/64	1	A/M/M/B	$350
STAN	UA/UI	64/64	2	U	$300 G $250 N
Statpro	UA/UI	64/128	2	—	$2000
SYSTAT	8/P/X	56/256/500	2	—	$495
TWG ELF	A/8/6/P	48/64/128/128	1/2/2/2	A/—/—/—	$200 A/E $300 S
TWG ARIMA	A	48	1	A	$300 A/E $400 S
Wallonick Statpac	8/P	64/128	2	—	$399

1/ 8 = CP/M-80, 6 = CP/M-86, P = PC-DOS or MS-DOS, A = Apple DOS, B = B DOS, UA = Apple Pascal, UI = IBM Pascal, R = Atari DOS, X = Unix
2/ Listed in same order as the operating systems
3/ A = Applesoft BASIC, B = IBM BASIC, M = Microsoft BASIC, R = Atari BASIC, U = UCSD Pascal, p-code, Z = BaZic
4/ A = Apple, I = IBM, G = with graphics, N = no graphics, E = 8-bit DOS, S = 16-bit DOS

Table 1: *Program requirements.*

Table 2 covers general program features.

Code Type/Extensibility: *A valuable feature found in several packages is the capacity to extend the program with user-provided routines. This was normally possible only for programs such as A-Stat, which were provided on unprotected disks and came in source code (usually BASIC). In a few cases, such as AIDA, the program author described how the user could add routines or change the program computations or display. In other instances, by providing the source code for the program, the author makes it possible for the user to modify the program. The table contains entries to show whether source code was provided and whether methods for extending the package were provided and documented.*

Copyability: *The table notes if the package is copyable, allowing the purchaser to make backup copies. Unfortunately, some of the packages are distributed in a protected format that does not easily allow the creation of archival copies.*

Separate Programs: *The packages consisted either of a single program, perhaps containing subprograms automatically chained together, or of a series of individual programs. In the latter case, typified by NWA Statpak, the user must select and run the appropriate program for each purpose, returning each time to the operating-system level. A series of separate programs is, in our minds, less desirable since it is more confusing to the user, who must remember which program does what. Because it forces rereading of the data set as each new program is run, such a package can be time-consuming to operate.*

Operation Style: *The statistical packages operate either through the use of menus or by a command language that is described in the table as Operation Style. A menu (coded M) provides an on-screen display of the options that can be selected at each step. A command language (coded C), such as that used by AIDA, displays only a program prompt on the screen while awaiting a syntactically correct reply from the user. We find the use of menus easier for the uninitiated; it certainly permits quicker initial use of the software. Once learned, however, a language allows the operator to select the desired options without having to answer a series of questions. A-Stat recently added a series of menus in addition to its command language.*

A second aspect of ease of use is the presence of long sequences of prompts or questions (coded Q) from which the operator cannot escape, and which must be repeated each time a similar application is requested. This characteristic is usually associated with the menu style of operation. An improved method would allow for abbreviated entry by a more experienced user or for a method to escape from a program path entered by accident.

Batch Mode: *The ability to use an external text file of commands to run the program, referred to as a batch operation on mainframe computers, is a useful option. While the advantages of a personal computer include interactive operation, the processing time for large data files may preclude a quick turnaround. A batch-mode option lets you submit a series of requests and leave the computer to process them.*

Escape Option: *Another aspect of ease of use is an escape sequence. This should be included in any system to allow escape*

	Code Type[1]	Extensible	Copyable[2]	Separate Programs	Operation Style[3]	Batch Mode	Escape Option	Help Function	Error Handling[4]
ABSTAT	O	—	Y	—	C,Q	Y	Y	Y	G
AIDA	S	Y	Y[f]	—	C,Q	Y	—	Y	G
A-Stat	O,S	—	Y	—	M/C,Q	Y	Y	—	G
Dynacomp Regr 1	S	Y	Y	—	Q	—	—	—	P
Dynacomp Regr 2	S	Y	Y	—	Q	—	—	—	P
Dynacomp Multilin	S	Y	Y	—	Q	—	—	—	P
Dynacomp ANOVA	S	Y	Y	—	Q	—	—	—	P
HSD Stats Plus	?	—	—	—	M,Q	—	Y	—	F
HSD Regress II	?	—	—	—	M,Q	—	Y	—	F
HSD ANOVA II	?	—	—	—	M,Q	—	Y	—	F
Introstat	S	—	Y	—	M,Q	—	—	—	F
Microstat	O	—	Y	—	M,Q	—	—	—	P
Micro-TSP	?	—	Y[f]	—	C,M,Q	Y	—	—	G
Number Cruncher	S,*	—	Y	—	M	—	—	—	P
NWA Statpak	S	—	Y	Y	Q,C	—	—	—	F
SAM	S	—	—	—	M,Q	—	Y	Y	P
SpeedSTAT Vol. I	S	—	—	—	M,Q	—	Y	—	G
SpeedSTAT Vol. II	S	—	—	—	M,Q	—	Y	—	G
SPS	S	Y	Y	—	M,Q	—	Y	—	F
STAN	O	—	Y	Y	M,Q	Y	—	Y	P
Statpro	O	—	Y	—	M,Q	—	Y	Y	F
SYSTAT	O	—	Y	Y	C	Y	—	Y	G
TWG ELF	S/O	—	Y	—	M,Q	—	—	—	P
TWG ARIMA	S	—	Y	—	M,Q	—	—	—	P
Wallonick Statpac	O	—	Y	—	M	Y	—	—	F

1/ S = Source, O = Object, B = Both, * = Protected BASIC, cannot list source code
2/ f = Programs are but boot disk is not copyable
3/ C = Commands, M = Menus, Q = Questions (listed in order of predominant use)
4/ G = Good (recoverable, explains, indicates source of error), F = Fair, P = Poor

Table 2: *General program features.*

	Equipment We Used[1]	Maximum Capacity[2] No. of Variables	No. of Cases	No. Data Items (000s)	Case-Handling Method[3]	Missing-Data Methods[4]	Variable Types[5]	No. Significant Digits[6]
ABSTAT	A,C,D	64	?	2	M	C/P/O/	R	7
AIDA	A	254	4000	17	V	C	R	4.5
A-Stat	A	45	?	D	C	C/P	R	9
Dynacomp Regr 1	A	2	?	?	M	—	R	9
Dynacomp Regr 2	A	2	?	?	M	—	R	9
Dynacomp Multilin	A	?	?	?	M	—	R	9
Dynacomp ANOVA	A	2	?	?	M	—	R	9
HSD Stats Plus	A	20	600	12	M	—	R	9
HSD Regress II	A	20	?	2	M	—	R	9
HSD ANOVA II	A	5	?	1–10 (V)	M	—	R	9
Introstat	A	?	?	4.8	M	?	R	9
Microstat	A,C,D	?	D	D	C	C	R	8/10/12/14
Micro-TSP	A,I	20/G	?	5	M	—	R	9
Number Cruncher	I	100	D	D	C	C	R	8
NWA Statpak	A,I	V	V	V	M,C	C	R,I,C	16
SAM	A	?	?	?	M	C	R,C	9
SpeedSTAT Vol. I	A	128	2048	13	M	P	I,R,C	4.5
SpeedSTAT Vol. II	A	128	2048	13	M	C	I,R,C	4.5
SPS	A	?	?	4	M	C	R	9
STAN	A	31	D	D	C	C	R,C	7
Statpro	A,I	36/72	750/ 1200	27	C	C/P	R	7
SYSTAT	K,I	50/75	D	D	C	C/P/O	R,C	15
TWG ELF	A	250	M	M	C	C/O	R	9
TWG ARIMA	A	?	?	0.5	M	—	R	9
Wallonick Statpac	I	255	5000	D	C	O	R	?

1/ All entries in this and the following tables were evaluated with respect to versions tested on this equipment. A = Apple II+ with 64K bytes of RAM, C = CP/M card, D = 80-column card, I = Compaq or IBM PC with 256K bytes, K = Kaypro II
2/ (Capacity may vary among package versions.) D = Limited by disk capacity, G = 58 variables allowed if graphics not used, M = Multidisk (unlimited capacity), V = Varies by program
3/ M = Memory, C = Read case by case, V = Virtual memory
4/ C = Casewise, P = Pairwise, O = Other
5/ R = Real, I = Integer, C = Character
6/ More significant digits may be available for other operating-system versions
7/ e, where range is $\pm 10^e$
8/ N, where N is the maximum number of categories allowed
9/ N = Numeric, C = Character, B = Both N and C, P = Position of variable in file record

Table 3: *Limitations on the data.*

from the current operation, should it be entered incorrectly.

Help Function: *Several of the packages, such as ABSTAT, STAN, and SYSTAT, contain a help function to obtain a description of the options currently available.*

Error Handling: *In the best of all worlds, a user who encounters a problem will receive a detailed message showing how to exit from the current predicament and correct the problem. Unfortunately, the error handling in many of the packages is poor. The user is rarely given insight into the source of the problem and is occasionally thrown forcibly out of the program.*

Table 3 covers limitations on the data.

Maximum Capacity: *Although most packages operate on computers with as little as 48K bytes of memory, they have limitations on the number of cases, number of variables per case, or on the product of these (referred to as data items). In many instances, the limitation is due to a requirement that the entire data set fit in memory or on a single storage disk.*

In other situations, the file size is limited by the dimension of arrays. This limitation can be overcome if source code for the package is provided. Some of the packages request the number of variables to be used and then indicate the number of cases that can be used. These programs dynamically dimension the storage.

The limitation may be on the total number of cases (rows of the data array) or variables (columns of the data array). Alternatively, it might be a limit on the total number of data items. The table identifies either the upper limits on number of cases, number of variables per case, or total number of data items, when these were specified. In some instances, when the limits were not stated, we were able to determine these limits by examining the source code.

Case-Handling Methods: *The approach to data handling used by the program is described in one of three ways. On one extreme, coded M and exemplified by SpeedSTAT and ABSTAT, the entire data set must fit into memory. This limits the amount of data while maximizing the speed of processing. At the other extreme, coded C, programs such as A-Stat and STAN process the data set one record at a time. The entire data set must be read for each function. This approach maximizes the amount of data that can be handled but slows processing. A preferred method, coded V and*

Value Ranges Quantitative[7]			Variable Identifiers	
Real	Integer	Qualitative[8]	Type[9]	Max. Length (if char.)
17	—	—	B	8
4.5	—	100	B	10
37	—	20	B	255
37	—	—	P	—
37	—	—	P	—
37	—	—	P	—
37	—	—	P	—
37	—	—	B	6
37	—	—	B	6
37	—	—	B	6
37	—	—	B	10
?	—	—	B	5
37	—	—	C	6
38	—	—	N	—
38	4.5	?	P	—
37	—	?	B	4
3.1	8	1296	B	16
3.1	8	1296	B	16
37	—	—	C	4
38	—	127	C	8
38	—	—	B	9
35	—	50	B	12
37	—	—	C	8
37	—	—	C	8
37	—	?	C	40

used by AIDA, has the appearance of a virtual system. In this system, variables are called into memory as they are needed. If a variable not currently in memory is needed, it will be read into memory at that time.

Missing-Data Methods: *Statistical packages typically handle missing data in one of two ways. One method is to exclude an entire case from the analysis if any variable is missing within the case. This method obviously eliminates a lot of cases. An alternative is to exclude only the missing variable value from statistical operations that require it. For example, regression analysis requires a sum of cross products. In pairwise deletion, a case with a missing value on one variable will be treated as follows: the missing variable cannot be used in the computation of cross products that contain it; however, all other variable cross products will be computed for the case. A description of the treatment of missing data is shown as C = casewise deletion, P = pairwise deletion, O = other, or "—" = none. Preparation for missing data varies by package. Often, a specific character or value is required to denote missing data.*

Variable Types: *Three data types were found: real, integer, and character. Few packages permit all three types as allowable input.*

Maximum Decimals/Value Ranges: *We describe the precision of usable data in two ways. For real and integer data, the table gives the absolute range of values as a power of 10 (e.g., 10+En). It also shows the number of digits of precision used in computations when this was noted in the documentation. For qualitative data, the table indicates the number of unique levels permitted.*

Variable Identifiers: *The nature and length of user-supplied labels are shown. Typical options for identification are numeric only (e.g., VAR001), alpha only (e.g., AGE or INCOME), or a choice of either.*

Table 4 covers documentation.

The user must depend heavily on the documentation provided with the package and on-screen displays to learn how to use the program and to resolve problems. The documentation is enhanced if it contains a tutorial including example applications. For packages that present menus and questions, sample runs should be included to indicate typical responses. For packages that are command oriented, an alphabetized reference section is helpful. Regardless of operating style, an index should be included.

Other items noted in the documentation comparisons are whether there is a reference card summarizing the available commands, a description of the technical formulas, and a list of technical references relevant to the statistical procedures. A list of formulas used in computations would clarify the procedures used by the program's author. NWA Statpak, SpeedSTAT, and Statpro had extensive documentation on the formulas used in their computations. We comment on these matters of documentation and offer our overall assessment of ease of use.

Data Management and Processing

In these tables, we describe how the packages manage and process data. First we discuss the entry, editing, storage, retrieval, and display of data. Then we talk about the packages' ability to process the data through subsetting, merging, sorting, and transforming.

Table 5 covers data management.

Keyboard Entry: *Almost all statistical software packages permit the entry of raw data from the keyboard. However, some packages running under CP/M or UCSD Pascal require the data to be prepared in a machine-readable form with an operating-system editor or by output from another program. The table indicates whether the package permits you to enter the data from the keyboard.*

Access Foreign Data: *Another characteristic we examined was the capacity to read from or write to files that can be used or created by other programs. First, we note whether the package can access a standard operating-system file. This is typically an ASCII file with fixed column positions for variables or with a delimiter such as a comma or space between variables. To access the standard file, you may need to reformat it using a utility provided with the package or your own program designed according to information provided in the documentation.*

One increasingly common format is that of the DIF (Data Interchange Format) file introduced by Software Arts Products Inc. (creators of Visicalc). DIF is a standard format that authors can use to make their data files compatible. Another valuable file for-

	Number of Pages	Table of Contents	Index	Summary Card	Tutorial	Sample Runs	Formulas	No. Technical References	Easy to Use
ABSTAT	94	Y	Y	—	Y	Y	Y	0	Y
AIDA	89	Y	Y	Y	Y	Y	—	15	Y
A-Stat	140	Y	—	Y	Y	Y	—	5	Y
Dynacomp Regr 1	12	—	—	—	—	Y	—	0	—
Dynacomp Regr 2	14	—	—	—	—	Y	Y	1	—
Dynacomp Multilin	16	—	—	—	—	Y	Y	1	—
Dynacomp ANOVA	15	—	—	—	—	Y	—	2	—
HSD Stats Plus	104	Y	Y	—	Y	Y	—	5	Y
HSD Regress II	82	Y	Y	—	Y	Y	—	7	Y
HSD ANOVA II	52	Y	Y	—	Y	Y	—	—	Y
Introstat	57	Y	Y	—	Y	—	—	1	Y
Microstat	99	Y	—	—	—	Y	Y	1	Y
Micro-TSP	175	Y	Y	—	Y	—	Y	5	Y
Number Cruncher	78	Y	—	—	Y	Y	—	1	Y
NWA Statpak	250	Y	Y	—	—	Y	Y	2	Y
SAM	39	Y	—	—	—	Y	—	0	Y
SpeedSTAT Vol. I	174	Y	Y	—	Y	—	Y	7	Y
SpeedSTAT Vol. II	250	Y	Y	—	Y	—	Y	10	Y
SPS	115	—	Y	—	—	—	—	15	—
STAN	101	Y	—	—	Y	Y	—	11	Y
Statpro	381	Y	Y	Y	Y	—	Y	14	Y
SYSTAT	239	Y	Y	Y	Y	Y	—	63	Y
TWG ELF	118	Y	Y	—	Y	Y	—	8	—
TWG ARIMA	73	Y	Y	—	Y	—	—	16	-
Wallonick Statpac	105	Y	—	—	—	—	Y	2	Y

Table 4: *Documentation features.*

		Access Foreign Data					Edit		
	Keyboard Data Entry	Standard System Files	DIF Files	dBASE II Files	File Documentation[1]	Single Data Structure	Change	Add	Delete
ABSTAT	Y	Y	—	Y	—	—	Y	Y	Y
AIDA	Y	Y	—	—	I	Y	Y	Y	—
A-Stat	Y	Y	Y	—	G	Y	Y	Y	—
Dynacomp Regr 1	Y	Y	—	—	—	—	Y	Y	Y
Dynacomp Regr 2	Y	Y	—	—	—	—	Y	Y	Y
Dynacomp Multilin	Y	Y	—	—	—	—	Y	Y	Y
Dynacomp ANOVA	Y	Y	—	—	—	—	Y	Y	—
HSD Stats Plus	Y	Y	—	—	I	—	Y	Y	—
HSD Regress II	Y	Y	—	—	I	Y	Y	Y	Y
HSD ANOVA II	Y	Y	—	—	G	—	Y	—	—
Introstat	Y	Y	—	—	G	Y	Y	Y	Y
Microstat	Y	—	—	—	G	Y	Y	Y	Y
Micro-TSP	Y	Y	Y	—	I	Y	Y	Y	Y
Number Cruncher	Y	—	—	—	I	Y	Y	Y	—
NWA Statpak	Y	Y	—	—	G	—	Y	Y	Y
SAM	Y	Y	—	—	I	Y	Y	Y	Y
SpeedSTAT Vol. I	Y	—	Y	—	—	Y	Y	Y	—
SpeedSTAT Vol. II	Y	—	Y	—	—	Y	Y	Y	Y
SPS	Y	Y	Y	—	G	Y	Y	Y	Y
STAN	—	Y	—	—	G	Y	—	—	—
Statpro	Y	Y	—	—	—	—	Y	Y	Y
SYSTAT	Y	Y	—	—	I	Y	Y	Y	Y
TWG ELF	Y	Y	Y	—	G	Y	Y	Y	—
TWG ARIMA	Y	Y	Y	—	G	Y	Y	Y	—
Wallonick Statpac	Y	Y	—	—	G	Y	Y	Y	Y

1/ G = Good, I = Incomplete
2/ F = Flexible, I = Inflexible
3/ Y = Package provides the means to turn printer on and off, A = To print a run session, user must direct all output to a text file by a command given at beginning of the session of each module and then list the text file

Table 5: *Data management.*

mat is that used by the dBASE II database package that operates under CP/M, CP/M-86, and PC-DOS. The table notes if either of these formats is supported. Table 5 also indicates if a standard operating-system ASCII file can be generated and read by the program.

File Documentation: *Most packages use their own file format for storage of data. If standard system files cannot be read or written, it is important that the internal file format be documented. Without this, you will be limited to keyboard entry of data and will not be able to use your data with any other program. Table 5 indicates if adequate documentation is provided to permit access to internal files.*

Single Data Structure: *An important data-management feature that is related to ease of use is the nature of the data structure employed. Most programs use a single data structure in which the cases are rows of the file (records) and the variables are columns. Some packages, however, turn this definition around for some of the analytical options, defining a column as a sample or group. For example, both the HSD ANOVA II and Statpro ANOVA options use two different formats, depending on the type of analysis being conducted. This varying of a file definition is potentially confusing, and we believe that it should be avoided.*

Edit: *After initial entry, you may have to add new records, edit existing records, or delete unneeded records. These functions may be accomplished within the package or you may be required to do this yourself. None of the editing operations provided are full-screen activities. The usual method is to specify the record number and then the variable name that is to be changed. The current entry might then be displayed and the new entry requested.*

We point out that an edit function may not be considered necessary, especially if the required operating system provides an editor. Of course, the use of an external editor can result in some inconvenience. Discovery of data errors will necessitate that you exit from the package, complete the required edit, and then return to the statistical package. This is not as handy as being able to make corrections from within the program.

Store Results on Disk: *Another useful feature is the option either to print the output or to store it into a file that can later be used by a word processor.*

Print: *An obviously important feature of a statistical package is the ability to obtain a hard copy of the results. Flexibility in printed output is described in the table. As a minimum, you will want to display the data or a subset of it. The table indicates whether this printout has a rigid format (I = inflexible) or can be controlled (F = flexible). The ability to get hard copy of the session, including the numerical results and possibly the prompts and responses, is noted.*

Table 6 covers data processing.

Selecting Cases: *You may want to perform an analysis on a subset of your data or conduct simultaneous analyses on several subsets or strata. Most packages allow a degree of filtering of the file to analyze subsets. The table summarizes the presence of this feature; it notes if you can subset by case numbers or by variable ranges. Subsetting by variable range is usually done with logical statements regarding one or more variables. The table provides the following categories: S = single range, A = Boolean AND permitted, B = Boolean AND and OR permitted between ranges of variables, and V = a list of specific values may be requested. The A and B codes indicate that two or more logical statements can be specified either for a single variable or for two or more variables.*

Join Files: *You may need to expand an existing file with additional data representing new cases or new variables on old cases. The presence of either join operation is noted.*

Sort: *Sorting of a file may be desired or may be a requirement to correctly perform certain analysis options. In at least one package, the data must be sorted to obtain ranks. The table notes the presence of a sort operation.*

Transform: *Frequently, transformations of data are required. Transformations might include simple univariate functions such as logical operations, adding a constant, or taking logs. Alternatively, the transformation might involve computations such as addition or multiplication, which use more than one variable. We note whether the usual arithmetic operations (+, −, *, /) are permitted and whether other math functions can be used to create new variables from existing ones. We also check for the capability of generating random variables for use in simulations. The computation of some probability density function, cumulative density function, and inverse CDF is noted. While it may be possible to compute these using functions provided for transforming data, we indicate in the table if a specific, single-step transform is provided.*

Method: *The method of specifying the transformation varies. Some packages require a command with supplied parameters (denoted C), others use a menu to select the transformation (denoted M), and still others require a BASIC or Pascal-like formula to be supplied (denoted F).*

Conditional Transform: *This option lets you limit the transformation to only those cases that meet specific conditions, such*

Store Analytic Reports	Print		
	Formatted Data[2]	Run Session[3]	Results
Y	I	Y	Y
—	I	Y	Y
Y	F	Y	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	I	—	Y
—	F	—	Y
—	I	—	Y
—	F	Y	Y
—	F	—	Y
Y	I	Y	Y
Y	F	—	Y
Y	F	Y	Y
Y	I	Y	Y
Y	I	—	Y
Y	I	—	Y
Y	I	—	Y
Y	F	A	Y
Y	I	—	Y
Y	F	Y	Y
—	I	—	Y
—	I	—	Y
—	I	Y	Y

	Selecting Cases		Join Files		Sort[2]			Transform			
	By Case Number[1]	By Variable Range[1]	Casewise	Variable-wise	Max. No. Vars	Asc/ Descending	Variable Types[3]	Random Vars	Prob. Dens. Funct.	Cum. Dens. Funct.	Inverse CDF
ABSTAT	A	A	Y	Y	M	A	N	Y	—	—	—
AIDA	S	S	Y	Y	1	A	N	Y	—	—	—
A-Stat	S	S	Y	Y	M	A	C	Y	—	—	—
Dynacomp Regr 1	—	—	—	—	—	—	—	—	—	—	—
Dynacomp Regr 2	—	—	—	—	—	—	—	—	—	—	—
Dynacomp Multilin	—	—	—	—	—	—	—	—	—	—	—
Dynacomp ANOVA	—	—	—	—	—	—	—	—	—	—	—
HSD Stats Plus	—	A	Y	Y	—	—	—	—	—	—	—
HSD Regress II	—	A	Y	Y	—	—	—	—	—	—	—
HSD ANOVA II	—	—	Y	Y	—	—	—	—	—	—	—
Introstat	S	—	Y	Y	2	A	N	Y	—	—	—
Microstat	S	—	Y	Y	M	A/D	N	Y	Y	Y	—
Micro-TSP	S	—	Y	Y	—	—	—	—	—	—	—
Number Cruncher	—	—	—	Y	1	A	N	Y	—	—	—
NWA Statpak	A	A	Y	Y	1	A/D	N/C	Y	Y	Y	—
SAM	—	S	Y	Y	—	—	—	—	—	—	—
SpeedSTAT Vol. I	S	—	—	—	—	—	—	—	—	—	—
SpeedSTAT Vol. II	S	S	—	—	—	—	—	—	—	—	—
SPS	S	S	Y	Y	1	A	R	Y	—	—	—
STAN	—	—	—	—	M	A	N/C	Y	—	—	—
Statpro	S	A	Y	—	1	A	N	Y	—	—	—
SYSTAT	B	B	Y	Y	1	A/D	N	Y	—	—	—
TWG ELF	—	B	—	—	—	—	—	Y	—	—	—
TWG ARIMA	—	B	—	—	—	—	—	Y	—	—	—
Wallonick Statpac	—	B	Y	Y	1	A/D	N	—	—	—	—

1/ In one step: V = Value list, S = Single range, A = Boolean AND of ranges, B = Boolean AND and OR ("Case Number" is a variable with values assigned sequentially by the package. Thus, "time period" may serve as a case number.)
2/ M = Four or more
3/ N = Numeric, C = Character
4/ C = Command and parameters, M = Menu, F = Formula statements, Q = Questions

Table 6: *Data processing.*

	Means			Moments		Coefficients		
	Arithmetic	Harmonic	Geometric	Variance	Std. Deviation	Skewness	Kurtosis	Variation
ABSTAT	Y	—	—	Y	Y	Y	Y	Y
AIDA	Y	—	—	Y	Y	—	—	—
A-Stat	Y	—	—	Y	Y	—	—	—
Dynacomp Regr 1	—	—	—	—	—	—	—	—
Dynacomp Regr 2	—	—	—	—	—	—	—	—
Dynacomp Multilin	—	—	—	—	—	—	—	—
Dynacomp ANOVA	—	—	—	—	—	—	—	—
HSD Stats Plus	Y	—	—	—	Y	—	—	—
HSD Regress II	Y	—	—	Y	Y	—	—	—
HSD ANOVA II	Y	—	—	—	Y	—	—	—
Introstat	Y	—	—	Y	Y	—	—	—
Microstat	Y	—	—	Y	Y	Y	Y	Y
Micro-TSP	Y	—	—	Y	Y	—	—	—
Number Cruncher	Y	—	—	Y	Y	Y	Y	—
NWA Statpak	Y	Y	Y	Y	Y	Y	Y	Y
SAM	Y	—	—	Y	Y	Y	Y	—
SpeedSTAT Vol. I	Y	—	—	Y	Y	Y	Y	—
SpeedSTAT Vol. II	Y	—	—	Y	Y	Y	Y	—
SPS	Y	—	—	Y	Y	Y	Y	Y
STAN	Y	—	—	—	Y	—	—	—
Statpro	Y	Y	Y	Y	Y	Y	Y	Y
SYSTAT	Y	—	—	—	Y	Y	Y	—
TWG ELF	Y	—	—	Y	Y	Y	Y	—
TWG ARIMA	—	—	—	—	—	—	—	—
Wallonick Statpac	Y	—	—	Y	Y	Y	Y	—

Table 7: *Summary statistics.*

Transform				
+ − * /	Other Math Functions	Lag( ) (capability)	Method[4]	Conditional Transf.[1]
Y	Y	Y	F	A
Y	Y	Y	C/F	B
Y	Y	—	C	S
—	Y	—	M/F	—
—	Y	—	—	—
—	Y	—	[illegible]	—
—	—	—	—	—
Y	Y	—	M	—
Y	Y	—	M	—
Y	Y	—	M	—
Y	Y	—	F	—
Y	Y	Y	M	—
Y	Y	Y	F	—
Y	Y	Y	M	S
Y	Y	Y	Q,M	A
Y	Y	Y	F	—
—	—	—	—	—
Y	Y		M	—
Y	Y	—	M	—
Y	Y	Y	F	—
Y	Y	Y	M/F	A
Y	Y	Y	F	B
Y	Y	Y	F	B
Y	Y	Y	F	B
Y	Y	—	C/F	B

	Order Statistics			
Percentiles	Ranks	Trimmed Means	Min. & Max.	Use of Weights
—	Y	—	Y	—
—	Y	—	Y	Y
—	—	—	Y	Y
—	—	—	—	—
—	—	—	—	—
—	—	—	—	—
—	—	—	—	—
—	Y	—		—
—	Y	—	—	—
—	Y	—	—	—
—	—	—	Y	—
—		—	Y	—
—	—	—	Y	—
—	Y	—	Y	—
—	Y	—	Y	—
—	Y	—	Y	—
—	—	—	Y	—
—	—	—	Y	—
—		—	Y	—
—	—	—	Y	—
—	Y	—	Y	—
—	Y		Y	Y
—	—	—	Y	Y
—	—	—	—	—
—	—	—	Y	—

as falling within a range of case numbers or having a specified range of values for some variable. If a case does not meet the conditions, it is generally given a missing value for the transformed variable. However, in at least one case, ...F, it is given the value of the previous case.

Statist... Functions

We cl... ied the statistical functions performed by ... es into one ... several categories: summary statis... graphics, ... parametric, linear models, and time series ... several packages ... weighting fo... data b... d on pr... eroscedastic ... Below ... descr... en case weig... ng is permi... d.

Tabl... y statistics. *In th... escriptive statistics, we vie... ly the ana... nd quantitative dat... tion bet... eful to prevent irrel... such as ... of the programs ... examined maint... ined such a d... te what summary ... tistics the pa... kages develop ... means, standard deviations and other momen... tion, percentiles, and order statistics (order statistic... smallest to largest of the sample values). In some cas... be obtai... ut only t... ultistep operation in... ing. Se... ackages ... tat) require precom... d storage of stati... s and ... input into linear-model options.*

Use of Weights: *Wh... zing s... vey data, it frequently necessary to use a weig... riable correctly r... ct the im... ... a weight variable ... compu... nsformation involving m... lying all t... e ... sis by the weight variab... owever, th... of ... work and the creation o... merous tran... iables.) ... option is ... e when*

...able 8 cover...

Since most persona... expected to find fairly ... d graphica... in statistica... this is the ... m the rule. Man... s, especial... of ... simple low-r... With two ... a- ... play features ... ms and ... ts. ... e Statpro gra... package ... n) provide ... er ... phica... riangular ... ts, ... nor ... k analys ... T's ... raphic... lude nor... m- ... our plot ... f display.

Graph... us pac... eneral fo... g codes ... text char... er displays, ... tes a l... -resolution display, ... H denotes ... f high-resolution pix... The table indicates whet... r display is provided ... r you can supply titles a... (Some packages labe... hs automatically, using the varia... names.)

The table notes if automatic ... mation of gr... ns is provided or if the user mu... ionally ... t-terplots are requested, ... e scaling and centering p... l-ly ... the program. Cl... h

	Mode[1]	Color	Titles	Labels	1-Var. Histogram	Histogram Grouping[2]	3-D Histograms	X-Y Scatter-plot	Scatter-plot Scaling[2]	3-D Scatter-plot
ABSTAT	T	—	—	—	Y	B	—	Y	B	—
AIDA	H	—	—	—	Y	M	—	Y	A	—
A-Stat	—	—	—	—	—	—	—	—	—	—
Dynacomp Regr 1	T	—	—	—	—	—	—	Y	A	—
Dynacomp Regr 2	T	—	—	—	—	—	—	Y	A	—
Dynacomp Multilin	T	—	—	—	—	—	—	Y	A	—
Dynacomp ANOVA	—	—	—	—	—	—	—	—	—	—
HSD Stats Plus	H	—	Y	Y	Y	M	—	Y	A	—
HSD Regress II	H	Y	Y	Y	—	—	—	Y	A	—
HSD ANOVA II	H	—	Y	Y	—	—	—	—	—	—
Introstat	H	—	—	Y	—	—	—	Y	B	—
Microstat	T	—	Y	Y	Y	M	—	Y	B	—
Micro-TSP	H	—	—	—	—	—	—	Y	A	—
Number Cruncher	T	—	Y	Y	Y	B	—	Y	B	—
NWA Statpak	T	—	Y	—	Y	B	—	Y	B	—
SAM	T	—	—	—	Y	B	—	Y	A	—
SpeedSTAT Vol. I	—	—	—	—	—	—	—	—	—	—
SpeedSTAT Vol. II	—	—	—	—	—	—	—	—	—	—
SPS	H	—	—	—	Y	M	—	Y	A	—
STAN	H	—	Y	—	—	—	—	Y	A	—
Statpro	H	Y	Y	Y	Y	B	—	Y	B	—
SYSTAT	T	—	Y	Y	Y	B	—	Y	B	—
TWG ELF	H,T	Y	—	Y	Y	A	—	Y	A	—
TWG ARIMA	T	—	—	—	—	—	—	Y	A	—
Wallonick Statpac	T	—	Y	Y	Y	M	—	Y	A	—

1/ T = Text, L = Low-Res, H = Hi-Res
2/ A = Automatic, M = Manual, B = Both, — = None
3/ P = Print, F = File, — = No, G = Lo-res graphics can be printed, hi-res can be saved to a file

Table 8: *Graphics.*

	Friedman Two-Way ANOVA	Kendall's Tau	Kolmogorov-Smirnov	Kruskal-Wallis H	Mann-Whitney U	Spearman Rank-Order Cor.	Wilcoxon Signed Rank	Wald-Wolfowitz Runs
ABSTAT	—	—	—	—	Y	Y	—	—
AIDA	—	—	—	Y	—	Y	—	—
A-Stat	—	Y	—	—	—	—	—	—
Dynacomp Regr 1	—	—	—	—	—	—	—	—
Dynacomp Regr 2	—	—	—	—	—	—	—	—
Dynacomp Multilin	—	—	—	—	—	—	—	—
Dynacomp ANOVA	—	—	—	—	—	—	—	—
HSD Stats Plus			—					—
HSD Regress II	—	—	—	—	—	—	—	—
HSD ANOVA II	—	—	—	—	—	—	—	—
Introstat	—	—	—	—	Y	—	Y	—
Microstat	Y	—	Y	Y	—	Y	Y	Y
Micro-TSP	—	—	—	—	—	—	—	—
Number Cruncher	Y	Y	—	Y	Y	Y	Y	Y
NWA Statpak	Y	Y	Y	Y	Y	Y	Y	—
SAM	—	—	—	—	—	—	—	—
SpeedSTAT Vol. I	—	Y	—	—	—	Y	—	—
SpeedSTAT Vol. II	—	Y	—	—	—	Y	—	—
SPS	—	—	—	—	—	Y	—	—
STAN	—	—	—	—	—	—	—	—
Statpro	—	—	Y	Y	Y	Y	Y	Y
SYSTAT	—	—	—	—	—	Y	—	—
TWG ELF	—	—	—	—	—	—	—	—
TWG ARIMA	—	—	—	—	—	—	—	—
Wallonick Statpac	—	—	—	—	—	—	—	—

1/ M = Depends on amount of free memory (RAM) (approx. 1000 cells), D = Depends on printer (80-col. printer: 10 × arbitrary; 132-col.: 19 × arbitrary)
2/ R = Row, C = Column, E = Cell

Table 9: *Nonparametrics and tables*

Box & Whiskers	Pie Chart	Save Graphics[3]
—	—	P,F
—	—	F
—	—	—
—	—	—
—	—	—
—	—	—
—	—	—
—	—	F
—	—	F
—	—	F
—	—	—
—	—	P
—	—	F
—	—	—
—	—	P,F
—	—	—
—	—	—
—	—	—
—	—	—
—	—	F
Y	Y	P,F
Y	—	P,F
—	—	G
—	—	P
—	—	P

types of display is the possibility of manual override of an otherwise automatic operation.

The table also indicates if other graphics displays, such as three-dimensional bivariate histograms, pie charts, or Box & Whiskers diagrams, are featured. (A Box & Whiskers diagram is a special form of histogram that identifies various percentiles. Its appearance is that of a box containing the median and denoting the second and third quartiles of the distribution surrounded by whiskers locating other percentiles.)

Finally, we note whether the package allows graphical displays to be printed directly or saved to a file. Typically, high-resolution graphics can only be saved to a file so the user is responsible for the printer interface.

Table 9 covers nonparametrics and tabulation capabilities. *Nonparametric statistics assume no underlying mathematical model to the data. They also do not make assumptions about the distribution of errors where parametric approaches usually require that data have a normal or Gaussian distribution. As the table shows, few packages provide these statistics.*

A description of the ability of the program to produce crosstabs of quantitative data is shown. We have included an entry indicating the computation of associated statistics, such as a test of the independence of rows and columns.

The table also shows which of several types of Chi-square tests can be performed. These include the usual test of independence of marginals, the goodness of fit, and other hypotheses of probability models, such as conditional independence or log-linear model parameters. Also noted is the ability to accept frequency counts as an alternative to creating and recreating the table from the raw data items for each analysis.

Kendall's Coef. of Conc.	Tables: No. of Dimensions	Tables: Max. No. of Levels[1]	Chi-Square Tests: Indep. of Marginals	Chi-Square Tests: Goodness of Fit	Chi-Square Tests: Log-Linear Models	Data Entry: Data Items	Data Entry: Frequencies	Calculate Percents[2]
—	2	D	Y	Y	—	Y	Y	R,C,E
—	2	100 × 100	Y	—	—	Y	—	R,C
Y	2	15 × 15	Y	—	—	Y	—	R,C,E
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
	5	9 × 9	Y	—	—	Y	Y	R,C,E
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	2	10 × 10	Y	—	—	Y	—	—
Y	2	5 × 20	Y	Y	—	Y	Y	E
—	—	—	—	—	—	—	—	—
—	2	?	Y	—	—	Y	Y	R,C,E
—	2	10 × 500	Y	Y	—	Y	Y	R,C,E
—	2	?	Y	—	—	—	—	R,C,E
—	2	128 × 2048	Y	—	—	Y	—	R,C,E
—	2	—	—	—	—	—	—	—
Y	2	10 × 10	Y	—	—	Y	—	R,C
—	—	—	—	—	—	—	—	—
—	2	12 × 9	Y	Y	—	Y	Y	R,C,E
—	50	50 × 50	Y	Y	Y	Y	Y	R,C,E
—	3	M	Y	—	—	Y	Y	R,C,E
—	—	—	—	—	—	—	—	—
—	2	50 × 50	Y	—	—	Y	—	R,C,E

	Regression				T-Tests		ANOVA			
	Simple	Multiple[1]	Polynomial	Stepwise	Paired	Groups	N-way	Contrasts	Unequal Cell Sizes[2]	Random Effects
ABSTAT	Y	Y	—	—	Y	Y	2	—	—	—
AIDA	Y	Y	—	—	Y	Y	1	—	—	—
A-Stat	Y	Y	—	—	Y	Y	2	—	Y	—
Dynacomp Regr 1	Y	—	Y	—	—	—	—	—	—	—
Dynacomp Regr 2	—	—	—	—	—	—	—	—	—	—
Dynacomp Multilin	Y	Y	—	Y	—	—	—	—	—	—
Dynacomp ANOVA	—	—	—	—	—	—	5	—	—	—
HSD Stats Plus	Y	—	—	—	Y	Y	2	—	Y	—
HSD Regress II	Y	Y	Y	Y	—	—	—	—	—	—
HSD ANOVA II	—	—	—	—	—	—	5	Y	Y	—
Introstat	Y	—	—	—	Y	Y	2	—	—	—
Microstat	Y	Y	—	Y	Y	Y	2	—	—	—
Micro-TSP	Y	Y	—	—	—	—	—	—	—	—
Number Cruncher	Y	Y	—	Y	Y	Y	4	Y	Y	Y
NWA Statpak	Y	Y	Y	Y	Y	Y	3	—	—	Y
SAM	Y	Y	—	Y	Y	Y	10	—	—	—
SpeedSTAT Vol. I	—	—	—	—	—	—	—	—	—	—
SpeedSTAT Vol. II	Y	Y	Y	Y	—	—	—	—	—	—
SPS	Y	Y	—	—	—	Y	1	Y	—	—
STAN	Y	Y	—	—	—	—	—	Y	—	—
Statpro	Y	Y	Y	Y	Y	Y	3	—	Y	Y
SYSTAT	Y	Y	Y	Y	Y	Y	30	Y	Y	Y
TWG ELF	Y	Y	—	Y	Y	Y	2	—	—	Y
TWG ARIMA	—	—	—	—	—	—	—	—	—	—
Wallonick Statpac	Y	Y	—	—	Y	Y	2	Y	—	—

1/ More than two independent variables
2/ For higher than one-way ANOVA

Table 10: *Linear models.*

	Equipment Used[3]	Longley's Data (all 6 indep. vars.)	Longley's Data (3 indep. vars.)
ABSTAT	A,C	2.9	5.2
AIDA	A	2.0*	3.2*
A-Stat	A	3.2	5.0
Dynacomp Multilin	A	2.6	5.9
HSD Regress II	A	Refused	7.5
Microstat	A,C	5.2	Not Run
Micro-TSP	A	5.7	6.6
Number Cruncher	I	6.8	6.6
NWA Statpak	A,C	3.7	6.5
SAM	A	4.3	8.0
SpeedSTAT Vol. II	A	Refused	3.6*
SPS	A	1.8	4.9
STAN	A	Refused	7.6
Statpro	I	5.2	8.3
SYSTAT	I	9.0	9.0
TWG ELF	A	3.1	8.7
Wallonick Statpac	I	5.6	9.0
WRYALG[2]	B	Not Available	3.3

1/ All coefficients were rounded to 9 decimal digits before averaging
2/ WRYALG stands for the "worst routine you are likely to get" (see reference 1)
3/ A = Apple II Plus, C = CP/M card, I = IBM PC, B = mainframe computer; single precision, * denotes that input is restricted to 4.5 digits. We therefore had to manually adjust the regression coefficients by the appropriate power of 10.

Table 11: *Average accuracy of regression coefficients (maximum accuracy is 9 digits[1]).*

					Diagnostics				
Uses Weighted Data	Discriminant Anal.	Factor Anal.	Gen. Lin. Models	Save Residuals	Cor. Matrix	Var-Cov. Matrix	Inverse of Var-Cov.	Partial R	Durbin-Watson
—	—	—	—	Y	Y	—	—	—	Y
Y	—	—	—	Y	Y	—	—	—	—
Y	—	Y	—	Y	Y	—	—	—	Y
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	Y	—	—	Y	—
—	—	—	—	Y	Y	—	Y	Y	Y
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	Y	—	—	—	—
—	—	—	—	Y	Y	Y	—	Y	Y
—	—	—	—	Y	Y	Y	—	—	Y
Y	—	Y	—	Y	Y	—	—	—	Y
—	—	—	—	Y	Y	Y	—	—	Y
—	Y	Y	—	Y	Y	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	Y	Y	Y	Y	Y	—	Y	Y
Y	—	—	Y	Y	—	—	—	—	Y
—	Y	Y	—	Y	Y	Y	—	—	—
—	Y	Y	Y	Y	Y	Y	—	—	Y
Y	Y	Y	—	—	Y	—	—	—	Y
—	—	—	—	—	—	—	—	—	—
—	—	—	—	Y	Y	—	Y	Y	Y

The table also indicates the kinds of percentages that can be calculated: row, column, or cell.

Table 10 covers linear models.

Although regression analysis, discriminant analysis, and ANOVA are all variations of the General Linear Model, they are often treated as separate operations within a statistical package. Most programs examined provide distinct routines to perform these analyses.

Simple and Multiple: *A common use for a statistical package is the computation of simple or multiple regression coefficients and estimates of their significance. Most packages provide this capability. Programs performing these computations usually include the r-square (percent of variance explained) value as part of the results.*

Polynomial: *The table notes if a separate polynomial-regression option is available. Polynomial regression includes various powers, such as squares and cubes, of a single predictor variable. While transformations of the data may be possible to obtain the same result, a number of programs provide this analysis directly.*

Stepwise: *When examining a large set of potential predictor variables, the ability to step through them in an ordered way can be instructive. Stepwise regression lets you examine the incremental effects of the various predictors and determine how much added predictive power comes from including them.*

ANOVA: *The table indicates the level of complexity provided for ANOVA problems. It notes if higher than one-way analyses are permitted. If so, the capability for using unbalanced designs is described. Another feature identified is the ability to analyze repeated measure designs. Other useful options would be the display of estimated means, multiple range tests, and the specification of tests of contrasts. We have noted only the presence of tests of contrasts.*

General Linear Model: *Only a few programs, one example being STAN, permit the automatic generation of dummy variables from quantitative data. These variables can be used to conduct ANOVA or discriminant analyses (this feature is indicated in the table as the General Linear Model, GLM). If the GLM, ANOVA, or discriminant-analysis options are not present, the user must create the required dummy variables either by transformation, if available, or by direct entry of the design matrix.*

Discriminant Analysis: *This linear model is used to predict which of several groups a case belongs in based on a number of independent variables. It is a variation of multiple regression where the dependent variable is qualitative rather than quantitative.*

Factor Analysis: *This technique seeks the underlying variables that cause variation in the observed cases. Although a host of methods for defining factors are available, we have noted only if at least one option is provided.*

The area in which the packages differ greatly is in the additional support needed to conduct a thorough analysis. Merely computing the desired model coefficients and their significance is not enough.

Save Residuals: *One desirable option for most models is the storage of residual values, the differences between the observed and*

	Two-Stage OLSQ	Serial (Auto) Cor.	Cochrane-Orcutt	ARIMA	Moving Averages*	Fourier Analysis
ABSTAT	—	—	—	—	—	—
AIDA	—	—	—	—	—	—
A-Stat	—	—	—	—	—	—
Dynacomp Regr 1	—	—	—	—	—	—
Dynacomp Regr 2	—	—	—	—	—	—
Dynacomp Multilin	—	—	—	—	—	—
Dynacomp ANOVA	—	—	—	—	—	—
HSD Stats Plus	—	—	—	—	—	—
HSD Regress II	—	—	—	—	Y	—
HSD ANOVA II	—	—	—	—	—	—
Introstat	—	—	—	—	—	—
Microstat	—	—	—	—	Y	—
Micro-TSP	Y	Y	Y	—	—	—
Number Cruncher	—	—	—	—	—	—
NWA Statpak	—	Y	—	—	Y	Y
SAM	—	—	—	—	—	—
SpeedSTAT Vol. I	—	—	—	—	—	—
SpeedSTAT Vol. II	—	—	—	—	—	—
SPS	—	—	—	—	—	—
STAN	—	Y	—	—	—	—
Statpro	Y	Y	—	—	Y	—
SYSTAT	—	Y	—	—	—	—
TWG ELF	—	—	—	—	—	—
TWG ARIMA	—	Y	—	Y	Y	—
Wallonick Statpac	—	—	—	—	—	—

* Complete funtional routines. For capability to produce moving averages using lag with other transformations, see table 6.

Table 12: *Time series.*

predicted values. If the residuals are saved as a new variable, they can be plotted and examined using the graphics routines.

Diagnostics: *Other important support options for linear models include an analysis of residuals for the presence of autocorrelation (such as the computation of the Durbin-Watson d statistic) or with bivariate plotting. Yet other useful features include the computation of correlation or covariance matrices, crucial to the stability of the computed effects.*

Table 11 covers statistical accuracy.

In a broad sense, statistical accuracy means getting the correct answer to your problem. We have limited our examination to the results obtained for one type of problem, multiple regression, since most packages have this capability. Further, this is a commonly desired analysis.

Computation errors for a given set of data and specified model typically arise from one of three sources: the algorithm used (a feature of the program), the precision (limited by hardware and system software), and the condition of the data matrix. For multiple regressions, the computed coefficients are particularly affected by these errors while the predicted values and estimates of multiple correlation are comparatively unaffected (see references 1 and 3).

Algorithm and precision errors are likely to creep in during the process of calculating and inverting the sum of cross products matrix required to compute a regression. Many procedures exist for doing this, and many have notably poor precision since they involve taking differences of large quantities (see reference 8).

Several measures have been proposed to reflect the condition of the data. By this we mean the extent to which small changes in the data will produce large changes in the solution (see reference 4). As a test of performance, we calculated regression coefficients for a "troublesome" data set and compared them with the "best" result. The data consisted of 16 observations on seven national economic variables used for this type of comparison (see reference 3). The data is highly colinear and has a high perturbation index; that is, small changes will result in large differences in the estimated regression coefficients. Since the relative performance of the packages could change under another set of ill-conditioned data, we conducted a second test using a subset of the variables that was relatively well conditioned.

We compared the output of the packages for the ill-conditioned problem with the "best result known to us," obtained by Longley on a desk calculator. His results agree with the DORTHO (double-precision ORTHO) routine used by Beaton (see reference 6). We used the same method for the better-conditioned problem, as well. We must note that, for the ill-conditioned data, the "best" result differs substantially from the "correct" solution (see reference 1).

To measure the number of digits of agreement with the "best" result, we used a slight modification of a formula used by Wampler (see reference 7). For a calculated value, b, and a "true" value, t, the number of digits of agreement is

	Documentation	Data Management	Data Processing	Summary Statistics	Graphics	Nonparametrics & Tables	Linear Models	Time Series
ABSTAT	G	G	G	G	F	G	G	—
AIDA	G	G	G	G	G	G	F	—
A-Stat	F	G	G	G	—	G	G	—
Dynacomp Regr 1	F	F	—	—	F	—	F	—
Dynacomp Regr 2	F	F	—	—	F	—	—	—
Dynacomp Multilin	F	F	—	—	F	—	F	—
Dynacomp ANOVA	F	F	—	—	—	—	F	—
HSD Stats Plus	G	F	F	F	G	G	F	—
HSD Regress II	G	F	F	F	F	—	F	F
HSD ANOVA II	G	—	F	—	—	—	F	—
Introstat	G	G	G	F	F	G	F	—
Microstat	G	G	G	G	F	G	G	F
Micro-TSP	G	G	F	F	F	—	F	G
Number Cruncher	F	F	F	G	F	G	G	—
NWA Statpak	G	G	G	G	F	G	G	G
SAM	F	G	F	G	F	F	G	—
SpeedSTAT Vol. I	G	F	—	G	—	G	—	—
SpeedSTAT Vol. II	G	F	F	G	—	F	F	—
SPS	F	G	F	G	G	G	G	—
STAN	G	F	F	F	F	—	G	F
Statpro	G	F	G	G	G	G	G	G
SYSTAT	G	G	G	G	F	G	G	F
TWG ELF	G	G	F	G	G	F	G	—
TWG ARIMA	G	G	F	—	F	—	—	G
Wallonick Statpac	F	G	G	G	F	F	F	—

G = Good
F = Fair
— = None or Negligible

Table 13: *Ratings of main features.*

$$
\begin{array}{lll}
 & -\log(|b-t|/m) & \text{if } m<>0 \text{ and } b<>t \\
\text{or} & -\log(|b-t|) & \text{if } m=0 \quad \text{and } b<>t \\
\text{or} & d & \text{if } b=t
\end{array}
$$

where m is the minimum of the absolute values of b and t, and d is the digits of precision used by the statistical package. The table shows the value averaged over all coefficients in each data set for each package. As a comparison, we show this value for the "worst routine you are likely to get."

Table 12 covers time series.

Several packages provide for the analysis of serially correlated data. The possibilities are through two-stage ordinary least squares, computation of autocorrelation coefficients, Fourier power spectra analysis, moving averages, or ARIMA models.

Table 13 is a summary.

We have tried to summarize the various tables into one overview. This table contains a single rating (G = good, F = fair, and "—" = negligible) for each of the general categories examined. We produced this table by adding entries from the earlier tables.

Documentation: *To get a good rating here, a package had to have a table of contents, an index, and either a tutorial or sample runs. A fair rating was given if it had only an index or a table of contents and either a tutorial or sample runs.*

Data Management: *A good rating was given if the package could perform all the following: allow two or more edit functions (entry, edit, add, or delete), make a hard copy of an entire session, and access foreign data files. A fair rating was given if the package could do two or three of these.*

Data Processing: *To obtain a good rating, a package had to permit case selection, join and sort files, and perform transformations. A fair rating was given for two or three of these.*

Summary Statistics: *We gave a rating of good if the package could compute means and standard deviations, one other coefficient shown in the table, and order statistics. A fair rating was given for doing two or three of the four.*

Graphics: *This was a more difficult area to summarize. We settled on a good rating for the production of histograms and high-resolution scatterplots or for exceptional capabilities in the production of scatterplots. A fair was given for packages with only one of the two displays.*

Nonparametrics: *To obtain a good rating, the package had to produce tables and perform at least one nonparametric test. A fair rating was given for only one of these.*

Linear Models: *We rated a package good if it included both multiple regression and analysis of variance options (both might be accomplished through the use of the General Linear Model) and at least one diagnostic statistic. A fair rating was given for performing only one of the analyses.*

Time Series: *A good rating was given to packages with two or more of the displayed options. A fair was given for one option.*

Text continued from page 236:

execution speed and precision by choosing the appropriate interpreter, but the drawback is that all related parameters and data files must be matched to the chosen interpreter or the program crashes. For example, a data file created by the 14-digit-precision interpreter cannot be read by the 8-digit one. An additional section in the manual is badly needed to help users interpret commonly encountered error messages and to suggest remedies. Without doubt, long-term experience with Microstat would permit users to avoid these errors.

Ecosoft is planning to release a new version of Microstat written in the C language about the time this review is published. The compiled version should greatly improve the speed of execution.

Micro-TSP: This package provides regression-based tools for modeling and forecasting time series. The tools are four varieties of multiple linear regression (one dependent variable): ordinary least squares (OLSQ), first-order autoregressive correction of OLSQ (the Cochrane-Orcut method), and two-stage least squares with and without the autoregressive correction. Each technique is executed by a command that produces a table of the coefficients with their standard errors and t-statistics and some summary statistics, such as the adjusted R-squared, standard error of the regression, and the Durbin-Watson statistic. Micro-TSP remembers the coefficients from the most recent regression and uses them in the command that automatically generates forecasts over a user-specified period. The only other statistical command provides summary statistics, including a covariance matrix, for a group of series.

Several time series can be plotted simultaneously versus time by typing the command PLOT followed by a list of series names. PLOT(N) produces normalized plots of time series (subtract mean and divide by standard deviation of the series). A plot of the residuals from the most recent regression can be obtained by PLOT(R). Scatterplots of one series versus another can be obtained from the GRAPH command. PLOT and GRAPH produce high-resolution graphics on the Apple but require a color/graphics monitor adapter for the IBM PC.

Micro-TSP is easy to use and well suited for handling time series of up to several hundred observations each. We have several minor criticisms that could be corrected in future versions. The requirement that the user describe the time dimension of data in a file before the file can be loaded is unforgivable, especially since there is no way to obtain the information from within the package, although it is stored at the beginning of the file itself. Next, although the workfile feature provides a quick way to save all time series currently in RAM under one filename (a handy method for interrupting your work), Micro-TSP has two sets of file-handling commands: one for the time series in the workfile and one for the series on disks. Why not have just one set of commands with a consistent single-letter parameter to reference the disk?

The manual has a good introduction on how to use two of the four regression types in three chapters featuring case studies of actual problems and real data. The

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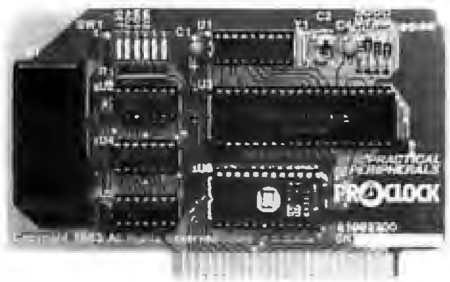

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other two types are described briefly but not illustrated.

Number Cruncher: This unpretentious program performs many tasks simply and well. It would probably not be ranked first in any single area, but it provides the common procedures one might want in each area. The main menu offers three choices plus exit. To begin, it is always necessary to either create or open a data file. You then choose from an array of 31 transformations on the second menu or proceed directly to the third menu of 13 different statistical procedures. Once a file is opened, it stays open through all the procedures until a new file is opened, and a status comment stays at the top of the screen naming the open file. Entering data to a file is easy, but adding variables to a full file is more laborious, necessitating the creation of a new file and the merging of both files, naming all variables again in the process. "Naming" the variables really means reassigning the variable numbers since the program does not accept character names.

A broad array of useful transformations is available, and new variables can easily be created, provided space for them was allocated when the data file was opened. When opened, all variables for all cases are initialized to 0, which lets most statistical procedures process the file without interference, even with "empty" variables allocated for future use. However, some statistical procedures get confused about zeros. One such case is the crosstab program, which leaves valid zeros off without accounting for them. Unlike many of the other procedures, the crosstab fails to document which variable numbers were used, so that the operator must religiously write down the appropriate numbers or be hopelessly confused two days later.

The regression results using the Longley data were among the most accurate of any program tested. Some procedures were simple enough to let a first-time computer user work independently after an hour of instruction. Though simple, certain aspects of the program are tedious, such as having to specify all 29 variables in our test data set over and over in the different procedures. For the most part, Number Cruncher was a pleasure to use and devoid of unpleasant surprises.

NWA Statpak: The wide range of procedures in NWA Statpak is attested to by the 78 separate programs provided. The mostly clear and comprehensive manual walks the user through each program with sample runs and organizes them in groups for easy reference. The very strength of such variety is also the package's major weakness, since each program must be run independently of the others. To perform a simple crosstab requires running several programs, each time entering the name of the file to open, the respective columns representing each variable (variable names are not supported), and all additional parameters requested by each program. The payoff, however, is ample. In return for this work, you can perform nearly any data manipulation or statistical task you might commonly encounter along with more than a few uncommon tasks.

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Input capacitance	20 pF	30 pF
CMRR	10 to 1 at 25 MHz	10 to 1 at 10 MHz
Channel isolation	100:1 at 25 MHz	Not specified
A Trigger sensitivity (int)	0.3 div at 5 MHz	0.4 div at 2 MHz
TV triggering	1.0 div compos. sync	2.0 div compos. sync
Sweep accuracy (in 10X)	4%, 15° to 35°C	5%, 20° to 30°C
Delay jitter	20,000 to 1 (2215A) 10,000 to 1 (2213A)	10,000 to 1 (2215) 5,000 to 1 (2213)
Holdoff Range	10:1	4:1

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vides some unique benefits. For example, many of the stand-alone data-manipulation programs can be used as general utilities. And, since the BASIC source code is provided, it is possible to modify all the programs for unique applications. The programming is exemplary in its clarity. Like many of the packages using interpreted BASIC, many procedures are notably slow. In professional applications, where speed of execution is an important factor, the programs can be compiled using either the Microsoft or IBM Compiler, as appropriate. Some modifications are required, but the clear programming makes necessary alterations straightforward, and the improvement in speed is considerable. All things considered, this serious, comprehensive package merits consideration by any CP/M user doing a wide variety of statistical analyses who wishes a large library of well-documented statistical programs in BASIC source code.

SAM: Developed in the United Kingdom, SAM performs a wide range of statistical functions. We found SAM to be one of the weaker packages. The manual is a brief 40 pages. About half of it consists of example printouts, leaving a text portion of about 20 pages. While the manual's cover suggests that SAM can be useful for survey analysis, SAM does not allow specification of a weight variable for analyzing probability samples. The SAM manual cover also indicates time series capability. However, the only related function we found was the ability to lag or lead data through a conversion (i.e., transformation) function. Obviously, the user could employ the correlation features to compute autocorrelation coefficients, but this is a multistep operation, not a menu option. On the plus side, SAM is easy to use and is one of the few packages providing a stepwise regression option.

SpeedSTAT: This series of individual programs will, when completed, provide a complete set of statistical functions. Currently, only two programs, Frequencies and Regression, are available. The Analysis of Variance and Time Series programs will appear shortly, and we have received a test version of the ANOVA package. The programs are very easy to use. The philosophy behind the packages appears to be that statistics can be used by most businesses to assess the "whys" behind their operation. The programs do not look or "feel" like typical statistical programs in that little, if any, statistical jargon is used and little statistical knowledge is required to obtain results. The accompanying manuals are quite complete, clearly documenting both the formulas used and the limitations of the data. We should point out that, like AIDA, SpeedSTAT stores data as 2-byte integers. Thus, even though you can specify a format for a field, the number of digits of precision is quite limited.

SPS: The version we worked with was developed for use at a university. As such, it was a bit rough when compared with commercial products. However, it is particularly strong in the area of experimental design, being one of the few programs featuring the General Linear Model. SPS provides many useful regression diagnostics not computed by many other packages. Among these are Press residuals and Mallows Cp. We recently received several new versions, including an improved version (4.2) for the Apple and another version for the IBM PC. The manuals for these are much more complete than those for the earlier versions.

STAN: This package provides complete support for linear models (regression, analysis of variance, etc.). It does not purport to be a general-purpose statistical program. With it, a knowledgeable user can analyze virtually any linear model likely to be encountered. STAN prepares dummy variables from qualitative ones, thus expanding its power beyond the limit on the number of variables found in table 5. That is, when performing an ANOVA, one qualitative variable with six levels requires five dummy variables in the analysis. Unlike the other packages, the table 5 entry for STAN refers to the number of variables, counting a qualitative variable as one, not one less than the number of its levels. Other packages may permit the user to create the five dummy variables and perform the analysis, but all five count against their limitations on number of variables. STAN computes the P-values (probabilities) of the test statistic. Most other packages require the user to look up the value in a suitable table.

Statpac: This program differs from most in that it is batch-oriented. While this initially seemed like an anachronism, in practice it proved to be quite useful. Before any runs could be carried out, it was necessary to first prepare a "codebook" file (giving variable names, value names, type of data, and so on), a "data" file (containing raw data), and an "analysis control" file (containing all the statistical commands and parameters for a run). While this slowed things up initially, it provided several advantages. For instance, you can correct any errors in the command syntax, variable names, or other entries without reentering everything else. Also, if you want to run parallel analyses on different variables, or slightly modified runs, it is simple to change one or two lines and rerun the entire procedure.

Other characteristics that set this package apart are value labeling, variable-recoding procedures, and a routine to handle multiple variable-responses. Value labeling lets you code values such as 1 = male and 2 = female, so that all tabular output will automatically include these labels for the appropriate rows or columns. Variable-recoding procedures include absolute recode, recode-if, select-if, compute, and compute-if. The multiple variable-response capability permits easy analysis of questionnaire items in which the respondent can give multiple answers.

Statpro: This is one of the most extensive and the most expensive of the packages we examined. Statpro runs under Softech Microsystems' UCSD p-System and performs many functions. (As a result of the extensive disk-storage requirements, the Apple version is delivered on sixteen 5¼-inch disks, most of which are double-sided.) The software comes in three subsystems, each with its own manual: one for database functions, one for statistics, and one for graphics. Among the programs we

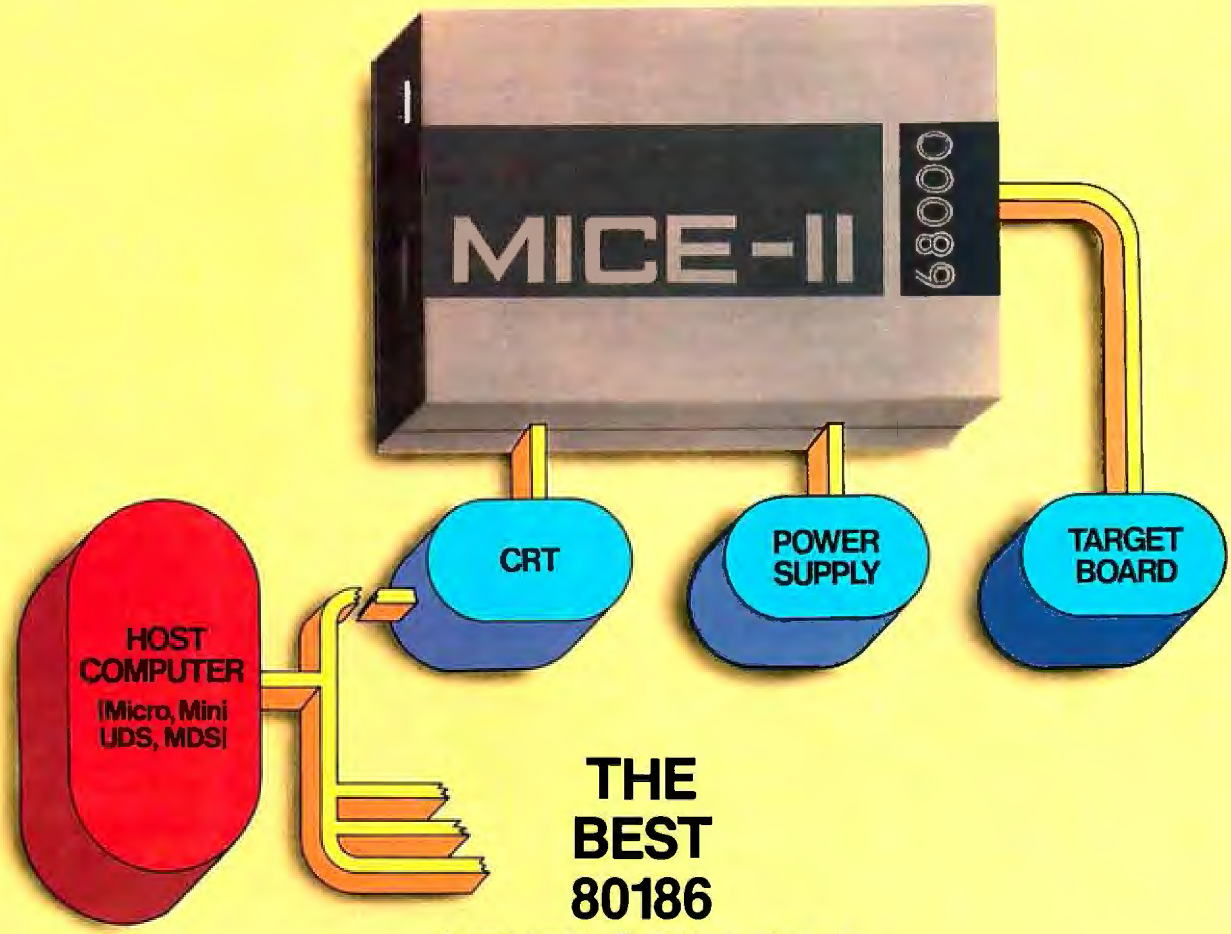
examined that run on an Apple, Statpro is far and away the most comprehensive package, computing more statistics and performing more analyses. Its graphics package is very thorough, containing options that include pie charts, triangular scatterplots, and normality curves for testing statistical assumptions. (The graphics package was not available in the prerelease IBM PC version we reviewed.)

While we have not tested Statpro in a hard-disk configuration, the user may want to operate it with such hardware. When using a floppy-disk system, the user is constantly requested to swap disks. Sometimes the user is requested to put a particular disk in one drive, yet for other purposes this same disk is to be put in the second drive. To use the complete system, eight separate work disks must be formatted using a utility provided with Statpro. The user will notice that Statpro has menus that duplicate entries from previous menus; that is, the same option may have to be requested twice from two consecutive menus to obtain the desired analysis.

SYSTAT: Although we have only recently begun working with this package, we find it to be one of the most powerful, with many mainframe characteristics. The version we reviewed ran on an IBM PC and required 256K bytes of RAM, although the CP/M version will run with only 64K bytes. It is command driven and uses a deceptively simple set of commands in view of the powerful procedures it provides. The manual presents examples of runs using all the commands in order to avoid the confusion that often results when generic commands are presented.

The real surprise came when we discovered the range, sophistication, and speed of SYSTAT's procedures. In addition to all the commonly used univariate statistics, SYSTAT was the only package to provide a multivariate general linear-hypothesis module, which includes multivariate analysis of variance, profile analysis of repeated measures, principal components analysis, and canonical correlation. It also provides modules for factor analysis with rotation and scoring and multidimensional scaling. The Tables module was the only one in our review to permit four-way and larger contingency tables, with analysis of log-linear models. The Graphics module offers a variety of options, including normal probability plots, contour plotting, stem-and-leaf diagrams, and detrended residual plots. However, graphical displays are formed by text characters, unlike the high-resolution color graphics of Statpro. Complex transformations of data are possible using an internal BASIC language that, like the rest of the package, was written in compiled FORTRAN. Other modules planned for release in the near future include cluster analysis of variables or cases, pen plotter graph routines, robust estimation routines, and time series analyses.

Another nice surprise was the speed with which the programs executed their calculations. When the output from the analysis of the Longley data was sent to the screen, the results were nearly instantaneous. Upon exiting each module, all RUN commands are printed auto-



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matically to provide permanent documentation.

SYSTAT supports the 8087 numeric coprocessor for the IBM PC. Without the coprocessor, the 80-bit floating-point standard is supported in software.

The Winchendon Group: The Winchendon Group (TWG) has two statistical packages: one for general statistics and one for analyzing time series by the ARIMA or Box-Jenkins method. The two packages are data-set compatible and have the same data-management and data-processing capabilities that can build and maintain data sets spanning several disks—a feature unique to TWG. However, the analytical limits of ARIMA are fewer than 500 observations.

The statistical capabilities of the Econometrics Linear Forecasting (ELF) package are adequately described in the tables. The ARIMA package has three analytical modules corresponding to the three phases of the Box-Jenkins procedure: model identification, estimation of the autoregressive and moving average coefficients of the model, and forecasting values of the time series. A plotting capability would be a useful addition to ARIMA—the manual even directs the user to examine a plot of the data during the identification phase. Likewise, the user is responsible for valid data ranges in transformations but cannot even get simple summary statistics like min and max.

Two problems with both programs are error handling and the basic structure of the manuals. Several times we were kicked out of the program with error messages such as BREAK IN LINE 2560, END OF DATA. After patiently following the example in the identification phase of ARIMA, we were rewarded with the message LOG OF NEGATIVE NUMBER. The structure of the manual does not correspond with the menus, and the menus are not even shown in the manual. This makes it hard to find what you need.

General Guidance

How practical are available microcomputer statistical packages for use in a research or business environment? Experienced mainframe statistical-package users tend to be especially suspicious of a microcomputer's capabilities. Yet, consider the wide range of features present in many of the packages shown in our comparison charts. The best of the packages are eminently practical for serious, professional applications. Many others look as though they would amply fill less demanding applications, sometimes at far less cost (although cost is an unreliable indicator of quality). Our tests show that the best of the packages equal or exceed the accuracy of many packages running on mainframes.

For both small data sets (e.g., fewer than 100 cases and 30 variables) and moderate ones (e.g., fewer than 2000 cases and 250 variables), it is not only possible to perform analyses on a microcomputer rather than a mainframe, it may even be the more desirable alternative. For example, in a professional research environment, the cost savings from using a microcomputer may pay for both the hardware and software in a relatively short time. Furthermore, day-to-day users may prefer the interactive features common in microcomputer packages to the batch-mode operation of most popular mainframe packages. In their current state of development, most microcomputer statistical packages take substantially more computer time to execute than mainframe packages do. In practice, the total elapsed time from keying commands until receiving printed output may not differ by much. Also, once a microcomputer is set up to perform a particular analysis, users can typically leave the machine for several hours while they go about other activities.

One advantage of microcomputer statistical packages, frequently exploited by those reviewed here, is sharing input and output with other applications packages. Many of the programs can accept input or generate statistical output for use in word-processing, graphics, database, and spreadsheet programs for direct integration of tables into finished reports or easy analysis of cases in database-management systems. The rows in table 5 relating to Accessing Foreign Data and Storing Analytic Results are particularly important to consider for such applications.

What is the range of statistical procedures available in microcomputer statistical packages? Even a cursory examination of our comparison tables will reveal that the most commonly used univariate and nonparametric analyses are available in one or another of the programs. Most of the packages have programs involving multiple independent variables, such as multiple regression, and a few have even more complex programs, such as factor analysis, multiple discriminant analysis, and canonical correlation. In short, the most commonly used statistical procedures are now available. The issue for a prospective buyer is whether needed procedures can all be obtained in one package, and whether that package will handle the number of cases in the user's data set on the user's microcomputer with a style of operation compatible with the user's preferences. We believe, based on our own experience, that most buyers will need to purchase more than one package to get all the features they require. A combination of packages should be able to share a data set in a common format.

How many cases and variables will they process? Some packages are limited to small data sets; others process multidisk data sets. Unfortunately, few of the manuals provided much detail about the number of cases and variables that could be handled on particular microcomputers having different available RAM. Nor did we have the time and resources to test the limits for any of them. Thus, while we are convinced that very large data sets can be processed by some of the packages, although perhaps awkwardly, we strongly advise prospective buyers who need this capability to consult with the developer or dealer first, as well as to arrange a trial period if possible.

How fast do they perform calculations? In a word, slowly. Many packages were written using interpreted languages, primarily BASIC. For small test data sets of 20 cases, the calculations seemed quite fast. But when the

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number increased to 100, 500, or more, the time needed for processing increased substantially. Some of the faster packages held all the cases in memory at once, but this seriously limited the number of cases that could be processed. Others were bound by incessant read-write operations on the disks and with the attendant hardware inefficiencies. A select few appeared substantially faster than others, but since we did not make any direct speed comparisons, we cannot provide objective information.

However, some packages facilitated the batch mode of operation by permitting simulated batch processing, so the microcomputer could be left running overnight. Anyone who has experienced the frustrations of working on a badly overloaded timesharing mainframe might even find that the total elapsed time from input to output is less for microcomputers.

We suggest that you suspend your prejudices about speed until you can actually give some of the packages a fair trial. Also, the time is soon coming when packages that are fast by any standard will become available. A select few of those reviewed here appear to have already surpassed some of the traditional speed barriers for microcomputer statistical applications.

How easy are they to use? Many of them can be easily learned by persons who have never used a computer to analyze data before. However, nearly every package assumes that the user has a basic familiarity with the statistics involved. Several of them were exemplary in the simplicity of their structure from the user's point of view. These were as easy to learn and as foolproof as any complex statistical-analysis package is likely to be. Almost all of them were easier to use than most of the common mainframe packages, but typically they provided far fewer procedures so that there was less to learn.

On the negative side, though, there were many problems. All packages had traits that annoyed us as we used them. No doubt we could adjust, given more time, but we were puzzled by the frequent inconsistencies and lapses in some of the otherwise well-thought-through programs. One of the most irritating aspects of many programs was the need to enter the same information about the number of cases, number of variables, filenames, system parameters, and so on over and over again as one proceeded through a series of related operations. Another annoyance was having to always move lockstep through a series of menus time and time again, usually from the very beginning each time, when doing parallel operations on different variables. Still another was the lack of an escape mechanism when a mistake is made or a filename forgotten at a crucial time. It was usually necessary to restart the program or, worse, reboot it when this happened. Sometimes this necessitated the reentry of our data set as well.

Many of the programs use the same key for different purposes at different times, without prompting the user about the change. As noted in our comparison table, some programs required the use of the Return key after some entries but not others. Packages varied from poor

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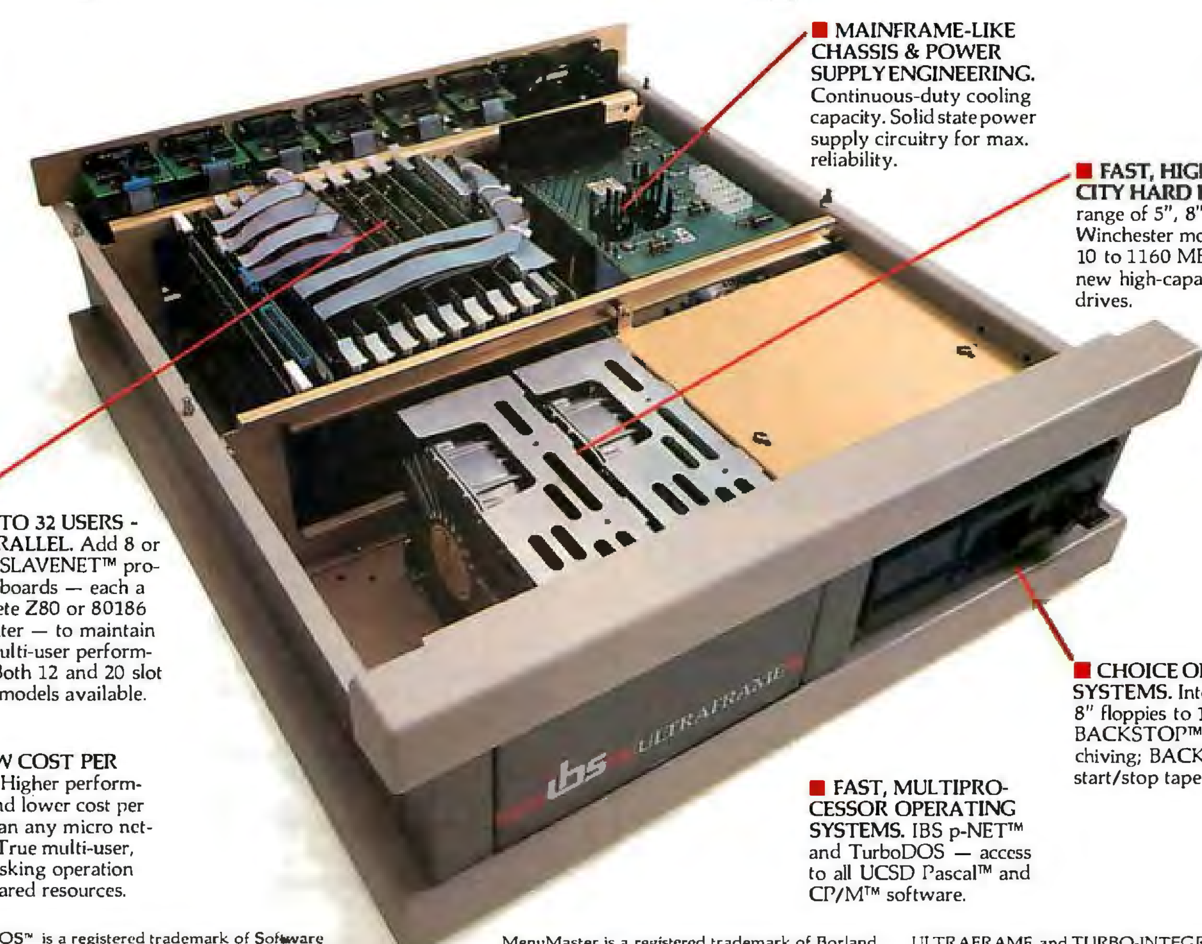

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to excellent in the amount of on-line help and prompting provided. The manuals were generally poor when it came to the intricacies of actually finding answers to questions we encountered while in the middle of runs, although there were a few notable exceptions.

The most serious problem of all, however, was the inability of most programs to adequately handle errors. It became routine to have the programs crash at inconvenient times, leaving us with an uninterpretable error message from the interpreter, compiler, or operating system. The manuals typically provided no help in these situations. Users who are experienced with the language or operating system used will have a decided advantage over novices when running these programs. But even experienced microcomputer users will find themselves handicapped when they get a fatal error from, say, a package written in BASIC, and discover that because it is a protected program they cannot list the line in which the error occurred to get a clue about the nature of the problem. And even in those cases where they can list it, users may find they spend considerable time studying the program code before they can decipher the problem. It is fair to say that, as a group, these programs are inferior to typical word-processing and spreadsheet programs in error handling. However, some packages were notably better than others in this regard.

Having vented our irritation at some of the quirks of these packages, we will of necessity adjust to them. In only a few programs are the benefits outweighed by the drawbacks of poor error handling, inconsistencies, and so on. Furthermore, as the market for these packages expands and users become more demanding, we can expect the same level of quality we now find in the best programs in other areas.

Which packages are best? We're going to hedge on this one and refer you to a careful study of the comparison tables. First of all, there was no clear favorite that we agreed on. This was partly dictated by our preference in operating systems and microcomputers. If you are used to Apple DOS, you might find yourself frustrated with CP/M, and vice versa, regardless of the merits of any particular program. Second, the needs of a specific application will usually tip the preference one way or another. Are your data sets large or small? Are you a novice or experienced? Do you prefer menu-driven or command-driven programs? Do you have an Apple, IBM, or CP/M microcomputer? Are you doing mostly crosstabs, regression, or time series analyses? Do you have to exchange data with other programs, such as spreadsheets or word processors? Do you need good graphics? All these questions and more will influence your buying decision. The best we can do is say that in our judgment many of these packages merit serious consideration, and we hope this review helps you find the right program to meet your specific needs.■

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This Month's Features

A new computer and an old language highlight BYTE's features in this issue. Any odd or peculiar articles, advertisements, or announcements can only be ascribed to that north-country, mid-winter affliction known as cabin fever—the theoretical cause of the wackiness common at April's arrival.

The new computer is the brainchild of a group of former Atari and Intel engineers headed by Roger Badertscher. The company and the computer are called Mindset. As Senior Technical Editor Gregg Williams explains, Mindset hopes to bring arcade-quality graphics to medium-priced personal computers.

The old language is BASIC, that standby of microcomputers that helped popularize the machines. Our examination of the current state of BASIC focuses on several new versions of the language that purport to improve on the evolved industry standard, Microsoft BASIC. The newer BASICs permit structured programming and use the increased power of the latest microprocessors. As you'll discover, windows mean a lot in this brave new world of BASIC, too. Our report looks at True BASIC, BetterBASIC, Macintosh BASIC, Professional BASIC, and BASIC-09. Will these new BASICs attract a following? Predictions not included.

You've no doubt been wondering what the Russians are up to. Ruth Heuertz reports on Soviet microprocessor technology in a feature beginning on page 351. Readers in the Commodore camp may find the VIC-20 Terminal Emulator program by John Russo of substantial interest (a VT100 for less than $100?).

Mark L. Siegel delineates the proposed ANSI standard for video terminals, exploring what may be a way to make screen control consistent among differing terminal brands.

Not more than one or two of us have been wondering what Jim McQuaid might be up to these days, but we all find out as he reveals details on a new home appliance, Smart Blankie. (Yes, there was a full moon the night this article was written.)

Next month, look for features on using cache memory to maximize the performance of hard-disk drives, batch processing with MS-DOS 2.0, and a look inside the ROM of the TRS-80 Model 100 portable computer.

—G. Michael Vose, Senior Technical Editor, Features

The Mindset Personal Computer

Gregg Williams
BYTE Senior Technical Editor

Custom VLSI chips bring $50,000 technology to a $2000 IBM PC-compatible computer

Photo 1: *The Mindset Personal Computer. In the background are the System (bottom) and Expansion (top) units. In the foreground are the detachable keyboard, an optional two-button mouse, and the supplied GW BASIC programming language in cartridge form.*

The Mindset Personal Computer (see photo 1) is a promising graphics-oriented computer that breaks new ground. It uses the Intel 80186 16/16-bit microprocessor (16-bit internal and external data bus) and two custom processor chips to create glitchless graphics at sufficient speed to make smooth animation possible. Taking its inspiration from graphics-oriented minicomputers costing more than $50,000, Mindset uses this state-of-the-art microcomputer technology to bring its price down to about $1200, with a full-blown two-disk system costing about $2600—and it also throws in a good amount of IBM PC compatibility at no extra cost. Mindset is slated to be available sometime during the second quarter of 1984.

Configurations and Prices

The Mindset can be configured in three different ways. The top two configurations include some IBM compatibility (allowing the machine to run the IBM PC versions of most major application programs without change). All three configurations include hardware that gives you very fast graphics and animation, even in BASIC.

Its simplest configuration includes the System Unit, which is a stand-alone cartridge-based personal computer. It includes an Intel 80186 microprocessor running at 6 MHz, 32K bytes of system ROM (read-only memory), 32K bytes of user RAM (random-access read/write memory), 32K bytes of screen memory (called a *frame buffer* by Mindset and many computer-graphics users), a detached 84-key keyboard with cable and two connectors for a mouse and/or Atari-style joystick, two cartridge slots, three I/O (input/output) module slots (for add-on hardware equivalent to Apple or IBM peripheral cards), a Mindset GW BASIC cartridge, and video outputs for a television, a composite color monitor, and an RGB (red-green-blue) monitor. At the time of this writing, Mindset estimates this computer's retail price will be about $1200.

The next step up includes the addition of the Expansion Unit, which fits on top of the System Unit and adds 96K bytes more RAM (for a total of 128K bytes of user RAM), one 360K-byte 5¼-inch (IBM PC-compatible) floppy-disk drive, and three I/O module slots. This unit brings the total computer price to around $2000 and gives you a disk-based computer with some IBM PC compatibility; it runs Microsoft's MS-DOS 2.0, available for about $60 extra.

The top-of-the-line configuration includes all the above plus a second disk drive and an additional 128K bytes of memory, both of which are added to the Expansion Unit. This gives you a two-disk, 256K-byte system that runs some IBM PC software for about $2600.

Using the Mindset, Saul Bernstein "painted" this view of an astronaut putting the world on line to represent this month's theme of real-world interfacing. (Photo by Michael Decastro.)

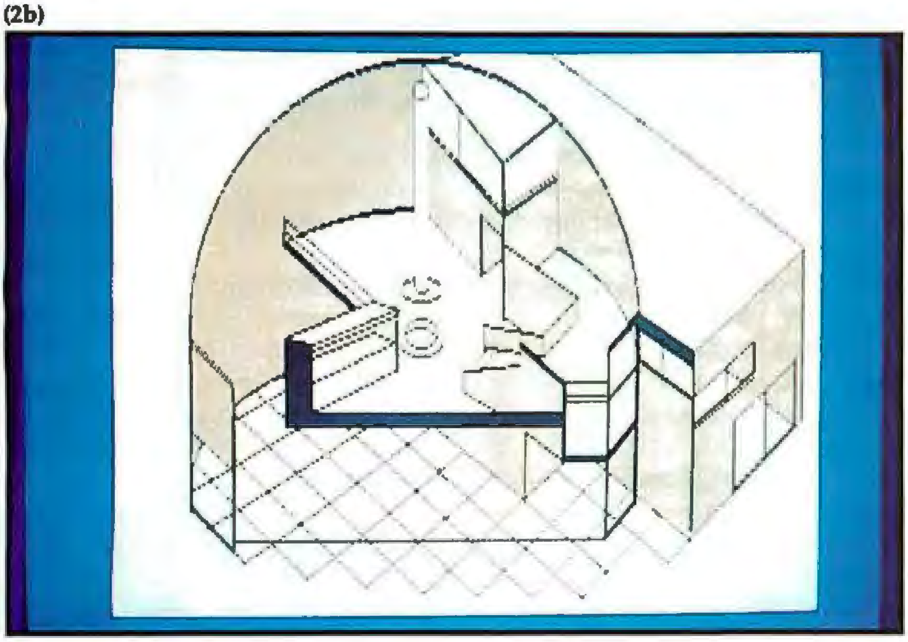
Design Philosophy

The inspiration for the Mindset computer came from two markets: the CAD/CAM computer and terminal market (machines costing $50,000 to $100,000) and the IBM PC market. (CAD and CAM refer to *computer-aided design* and *manufacturing*, respectively.) Mindset's vision was to make a computer with most of the graphics power of a CAD/CAM system for a consumer-computer price. Its approach was to adapt CAD/CAM technology to a smaller and less expensive computer by using custom VLSI (very-large-scale integration) chips to perform complicated graphics quickly and cheaply.

By working with a custom chip manufacturer, VLSI Technology Inc. of San Jose, California, and drawing on the expertise of employees who came from companies like Zilog, Intel, and Atari, the Mindset design team created two custom VLSI chips, one for pixel-oriented graphics and one for handling the video display, and designed a computer around them and the Intel 80186 microprocessor (an enhanced chip that runs a superset of the 8086 instruction set

(2a)

(2b)



(2c)

Photo 2: *Graphics on the Mindset. Photo 2a is an image created by PLP (presentation-level protocol) graphics commands. Photos 2b and 2c are done in the 640- by 200-pixel, 4-color mode.*

and replaces about 20 chips in a comparable 8086-based design). Intel designed its 8086 family of microprocessors to be able to use a family of yet-to-be-designed coprocessor chips that, in effect, extend the instruction set of the Intel 80186 (Intel's 8087 floating-point arithmetic chip is the best-known coprocessor chip). The custom graphics chip in the Mindset computer is actually a coprocessor chip, the first to be designed outside Intel.

The resolution of Mindset graphics is not appreciably more than that of an IBM PC, but Mindset made that decision to allow itself to offer a low-cost computer: higher-resolution graphics would have forced the user to buy an RGB color monitor costing anywhere from $1400 to $4000. Still, the Mindset shares the following characteristics with its more expensive CAD/CAM counterparts: bit-mapped graphics; color indirection (the ability to choose from 512 possible colors the 16 that can be in use at one time); custom hardware to perform pixel-aligned graphics operations quickly, regardless of byte and word boundaries; and custom software that delivers a set of useful graphics-oriented subroutines. Photos 2a through 2c show representative Mindset graphics.

Mindset added limited IBM PC compatibility to give it a considerable base of ready-to-run software. The company would have liked to have had 100 percent software compatibility, but this conflicted with some of its other goals. The Mindset computer is BIOS-entry-point- and graphics-screen-compatible with the IBM PC; this means that if a program uses the Microsoft MS-DOS BIOS (basic input/output system) calls and manipulates the graphics screen directly (as all programs should, but many don't), the Mindset can run the same disk without modification. Mindset tested many popular IBM PC packages and, if they didn't work,

Delineating IBM PC Compatibility

Mindset did not set out to create a computer that is IBM compatible; rather, it created a computer using radically different hardware from the IBM PC that can run many IBM PC programs. The distinction is small but significant. For one thing, it means that Mindset has made no attempt to be hardware compatible: you cannot use IBM PC expansion boards in the Mindset because it has no hardware slots. The irony of this compatibility situation is that if software designers programmed the way they were supposed to—using operating-system routines instead of direct manipulation of the hardware—and IBM had designed the PC to make it easier to do so, virtually all IBM PC programs would run as is on the Mindset.

According to Mindset, "Mindset is compatible with PC programs which run with the color card and which use standard ROM OS calls and/or MS-DOS 2.0 functions, or with PC-DOS 1.1 programs which map into PC-DOS 2.0." In addition, the Mindset works with programs that address video-display memory directly and make use of the 6845 video-display-controller status registers. (Because the Mindset does not use the 6845 for video display, it does not respond to most manipulations of it; however, so many IBM PC programs use it to find out when to write to video-display memory without causing visual glitches that Mindset emulates these registers.) In general, though, programs should call operating-system routines instead of manipulating the hardware directly (Mindset has provided a large number of operating-system routines in its computer to make direct hardware access unnecessary).

Differences between the characteristics of the IBM PC and the Mindset account for some inherent incompatibilities. Many of these have been discussed elsewhere: the "Keyboard" section of the main text, table 1 (operating-system-call differences), and table 8 (video-display-mode differences). For example, the Mindset will not run the popular Microsoft Flight Simulator because it uses the 160- by 100-pixel graphics mode, an IBM PC mode the Mindset does not allow. Also, the Mindset does not include BASIC in ROM or support the IBM-style light pen or joystick.

When using the IBM PC with a graphics-interface card in text mode, you can display characters with any combination of 16 foreground colors and 8 background colors and optional blinking. The Mindset supports blinking characters but only two color modes: black on white and white on black. By changing the color palette, you can display characters in other colors, but you will be limited to only those two colors on the display. In addition, the IBM PC has memory space for up to eight pages of 40-column text or four pages of 80-column text; the Mindset has reserved only enough memory for half that many alternate pages.

Finally, another source of software incompatibility occurs because of a hardware incompatibility between the 8088 and the 80186. According to Mindset, the vector that is used for keyboard I/O on the 8088 is dedicated in the 80186 to refreshing the system's dynamic RAM. This means that a program that reassigns the keyboard interrupt vector will not work on the Mindset.

Although the Mindset promises to work with many IBM PC packages, Mindset owners will be faced with an annoying uncertainty every time they see a piece of IBM PC software. In some cases, Mindset will have tested the software and determined its compatibility, but it can't keep up with the explosion of software we have today. The user's best bet is to deal with a software vendor that will let him or her try it before buying.

modified the computer so that they would. Many word processors (Peachtext, Wordstar, Superwriter), spreadsheets (1-2-3, Multiplan, Supercalc 3, Visicalc), databases (dBASE II, Condor), and other programs work as is.

The Mindset computer is incompatible with the IBM PC in that the former does not have a cassette interface; however, the operating system was designed to interact with cartridges as sequential-file devices. The Mindset computer also does not support a monochrome graphics display, light pen, IBM-style resistive joysticks, and some color graphics modes. For a more detailed look at this issue, see the text box "Delineating IBM PC Compatibility."

Open Software/Closed Hardware

Mindset recognizes the important role of third-party product developers in the success of a new computer, but it has taken a curious approach in its company policy toward them. It is actively promoting the development of third-party software (more on this later) but is rigidly guarding all details about the hardware itself, thus discouraging third-party hardware vendors and forsaking the increased popularity that comes from the availability of a large amount of hardware for the system. Mindset gives two reasons for its closed-hardware policy: first, to allow future versions of the hardware to include changes without making them incompatible with existing software; and second, to protect its design from imitation by competitors. Mindset's policy, for better or worse, limits the depth of technical information that follows.

Mindset is promoting the development of third-party software while discouraging third-party hardware vendors.

Machine Architecture

Figure 1 shows a block diagram of the Mindset personal computer. The diagram shows the contents of both the System and Expansion units. The system, graphics, and expansion buses have a 16-bit data bus and a 20-bit address bus. The system and graphics buses are joined by a *three-state bus buffer* that can either isolate or connect the bus lines on either side of it. In some cases, the system isolates the two buses so that the graphics coprocessor and display processor can perform a lengthy function (e.g., clearing the screen or refreshing the video display) without

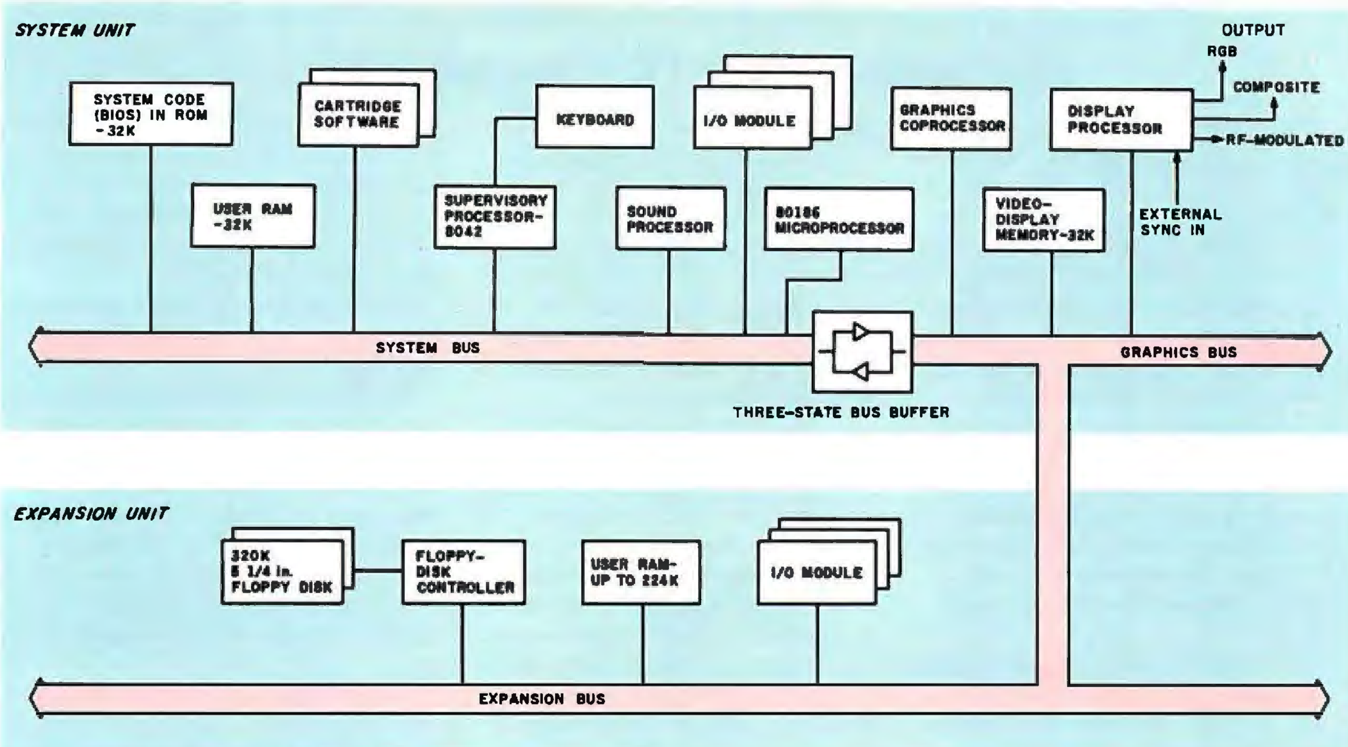


Figure 1: *Block diagram of the Mindset personal computer.*

tying up the 80186 and all the system components on the other side of the bus.

The Intel 80186 has a full 16-bit-wide data bus to complement its internal 16-bit architecture. Because it is not restricted by an 8-bit data bus (like the 8088 in the IBM PC), and because it runs at a higher clock rate (6 MHz instead of the PC's 4.77 MHz), the Mindset should run faster than the IBM PC. (For details on the effect of bus width on microprocessor performance, see my "Benchmarking the Intel 8086 and 8088," July 1983 BYTE, page 147.) A spokesperson at Mindset said that the company chose the 6-MHz 80186 over the 8-MHz version to ensure a "sufficient quantity" of the part for manufacturing the computer.

Interrupt Vector (Hexadecimal)	IBM PC Description	Mindset Description	Comments
2	Nonmaskable	Reserved	Vector 2 is a hardware interrupt that is implemented differently on the 8088 and 80186; Mindset uses this vector for a proprietary purpose but knows of no conflict when trying to use IBM software
10	Video	Video I/O	There is full compatibility except in video modes not supported by the Mindset computer
15	Cassette	Dummy IRET	The Mindset places an IRET (return from interrupt) here because it does not support cassette I/O
16	Keyboard	Keyboard I/O	There is full compatibility except where the Mindset keyboard differs from the IBM PC keyboard
18	Cassette BASIC	Dummy IRET	The Mindset does not need this vector because its BASIC is not in ROM
1D	Video Initialization	Reserved	The IBM vector returns information specific to its hardware; the Mindset ignores this vector

Table 1: *Deviations of Mindset interrupt vectors 0 through 1F hexadecimal from their IBM PC counterparts. The closer to identical these two are, the greater the degree of IBM PC compatibility; the differences here are very small.*

System Code in ROM

One significant feature of the Mindset is its use of system code in ROM (this is similar to the IBM PC); in this way, the computer can work as a stand-alone unit (without disk) or, if disks are present, software on the disk can "hook" the ROM software into itself and make it a disk-based system. The ROM software contains start-up instructions—what to do when the computer is first turned on. It also includes the computer's BIOS, a set of routines that let the programmer do character- and block-oriented input and output (and other elementary functions) without having to know the physical addresses or characteristics of the hardware being used. (The routines, when referred to by number, are called *interrupt vectors.*) For example, BIOS routine 16 decimal (called by the software-interrupt instruction INT 10, where "10" is the decimal number 16 in hexadecimal) controls 16 functions relating to the video display—setting the display type, reading the cursor position, putting a character to the display, and others.

Interrupt Vector (Hexadecimal)	Value in AH Register (Hexadecimal)	Function
Video Support		
EE	01	Writes a character string to the screen along with string's attributes
EE	02	Selects TV or monitor as display device and reloads color palette
EE	05	Sets the cursor shape for character modes
EE	06	Supports synchronization with external video devices
EE	07	Specifies scan line that generates a display interrupt
EF	0E	Returns frame-buffer address and sizes
Graphics Initialization		
EF	00 (01)	Sets (gets) screen-mode information
EF	02 (03)	Sets (gets) transparent and combination modes
EF	04 (05)	Sets (gets) address of destination buffer
EF	06 (07)	Sets (gets) write mask
EF	0A (0B)	Sets (gets) color-palette data
EF	0F (10)	Sets (gets) address of user-defined display interrupt routine
EF	12 (13)	Sets (gets) collision mask
EF	14 (15)	Sets (gets) clipping rectangle
EF	16 (17)	Sets (gets) the collision and clipping enable/disable flags and the address of the associated interrupt routine
EF	1F (20)	Sets (gets) pointer to user-specified font
EF	22 (23)	Sets (gets) the parameter-block mode value, which determines whether certain parameter lists are contiguous areas or linked lists
Graphics Primitive Operations		
EF	08	Basic bitblt operation: moves one rectangular area of graphics to another
EF	09	Fills a rectangular region with a 16-bit pattern
EF	0C	Draws a series of points of the same color
EF	0D	Draws a series of lines of the same color
EF	19	Draws a filled convex polygon
EF	1A	Draws a series of filled ellipses, circles, and pie sections
EF	1B	Draws a series of hollow ellipses, arcs, and circles
EF	21	Displays character strings at any location with a user-specified font
Miscellaneous Graphics		
EF	11	In a double-buffered graphics mode, switches display to alternate buffer
EF	18	Waits until the graphics coprocessor finishes current task, then returns collision and clipping results of the last 16 tasks
EF	1C (1D)	Saves (restores) the current state of the graphics coprocessor chip
EF	24	Poles the current status of the graphics coprocessor chip
Miscellaneous Nongraphics Commands		
EE	08 (09)	Sets (gets) the mode for (from) the real-time clock
EE	0C (0D)	Sets (gets) the time for (from) the real-time clock
EE	0E (0F)	Sets (gets) the date for (from) the real-time clock
EE	15	Formats a RAM cartridge to accept information and support a directory
EE	18 (19)	Reads (writes) blocks of data from (to) a RAM cartridge
EE	1F	Reads status of both joystick ports
EE	21	Turns off the power to the system
EE	24 (25)	Sets the sound mode (registers)
EE	26	Transfers sound data directly to the system D/A (digital-to-analog) converter
EE	28 (29)	Writes (reads) a character to (from) the RS-232C output (input) buffer
EE	2C (2D)	Sets up the RS-232C input (output) buffer

Table 2: *Important BIOS routines supplied by the Mindset ROM operating system.*

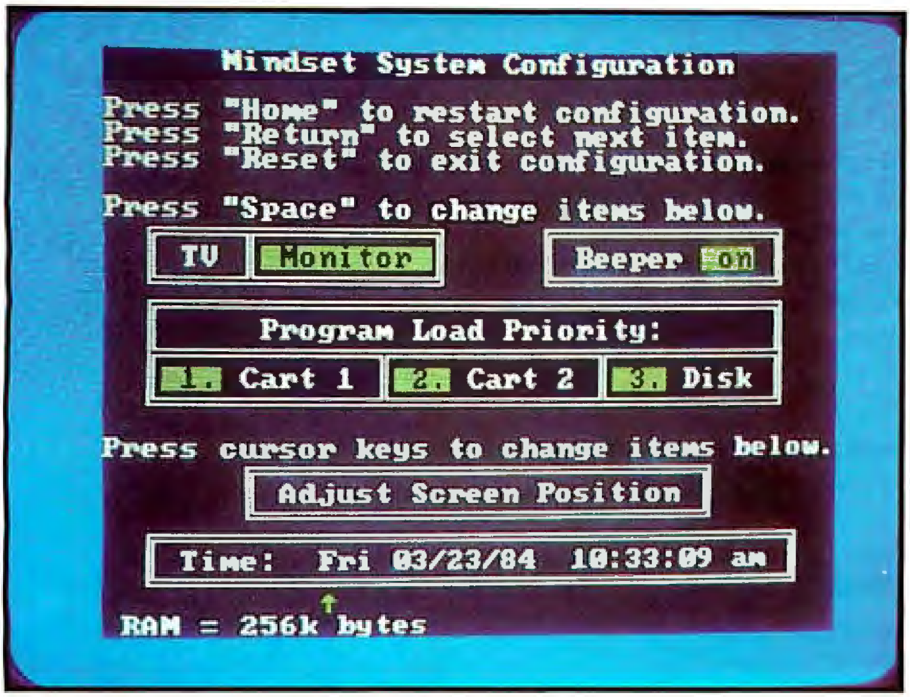


Photo 3: *The System Configuration screen appears at the beginning of a session when you hit the Sys Config key. This screen shows how much memory you have (see lower left corner) and allows you to change certain system parameters.*

Photo 4: *Although this Mindset keyboard is quite similar to the IBM PC keyboard, Mindset has made several improvements. Note, among other things, the more conventional layout of the function keys F1 through F10 and the improved position of the Shift keys.*

The Mindset BIOS routines are a superset of the IBM PC's, thus contributing to IBM compatibility. Interrupt vectors 0 through 1F hexadecimal are essentially the same as on the IBM PC (see table 1 for a list of differences). In addition, Mindset uses interrupt vector EE hexadecimal for 57 system-specific functions (distinguished by the value of the AH register when the interrupt is executed) and vector EF for 39 graphics-related functions (table 2 lists some of the more important EE and EF vectors). By creating an interrupt structure that includes all the basic interactions needed between a program and the system hardware, Mindset is strongly encouraging programmers to create code that will work on the computer even if Mindset changes the control addresses and even the implementation of some functions in hardware.

The system-specific BIOS routines include a set of RS-232C-related routines that allow data transfers to occur, interrupt-driven, as a background process. You can set up both input and output data buffers. Once you start an I/O operation, the system can send the data in the output buffer or receive external data into the input buffer automatically while the foreground program goes on to other tasks.

Many of the extended graphics BIOS routines will take a list of arguments, and one call to that routine will perform a given operation up to 65,535 times. For example, one BIOS call can draw 20,000 line segments of the same color, but you need to make two BIOS calls to draw two line segments, each in a different color.

Starting the Computer

If you want to use cartridge software in the Mindset, you insert the program in one or both of the cartridge slots and turn a dial on the left face of the computer to clamp the cartridge contacts in an internal zero-insertion socket. You can insert cartridges in either slot; the operating system can find the proper software to run, even if both cartridge slots are occupied.

The on/off switch is located on the back of the keyboard; however, it does not directly control the power. The supervisory processor (an 8042) remains active as long as the computer is plugged into a wall socket. It constantly "listens" for keypresses from the keyboard; the on/off switch is simply a keypress(es) that the 8042 uses to "wake up" the rest of the system.

The computer checks three sources for the code it will execute on start-up—the disk and the left and right cartridge slots. You can set the order of checking as well as other items such as time, date, and screen-image position (relative to the edges of the display area) by hitting the Sys Config key just after starting the system; this key causes the *System Configuration screen* to be displayed (see photo 3). The values chosen by modifying this screen remain in effect as long as the computer is plugged into an electrical outlet.

Keyboard

Photo 4 shows the Mindset keyboard. Mindset had the courage to

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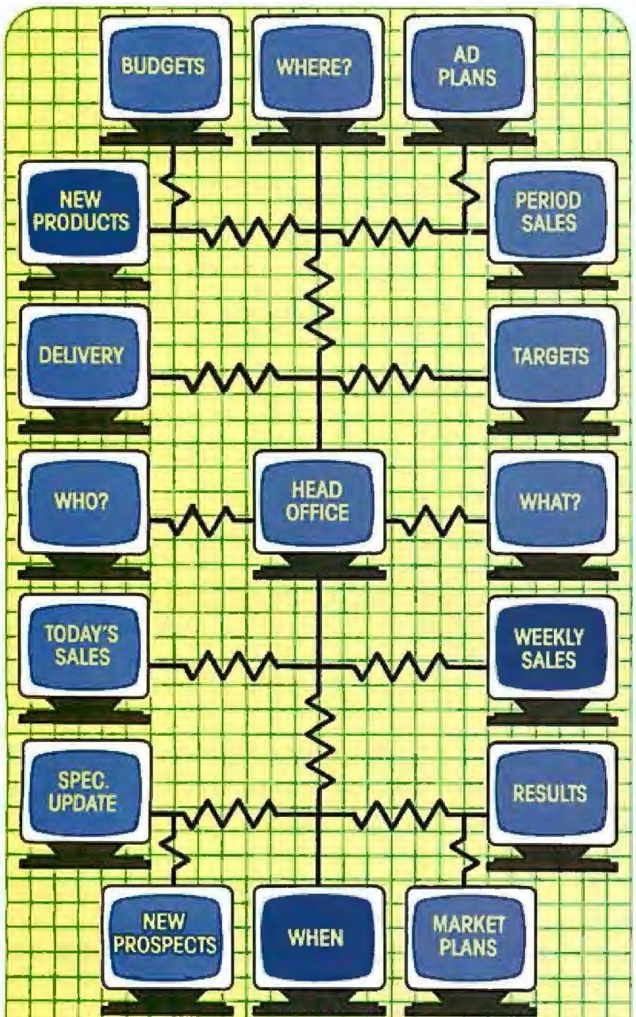

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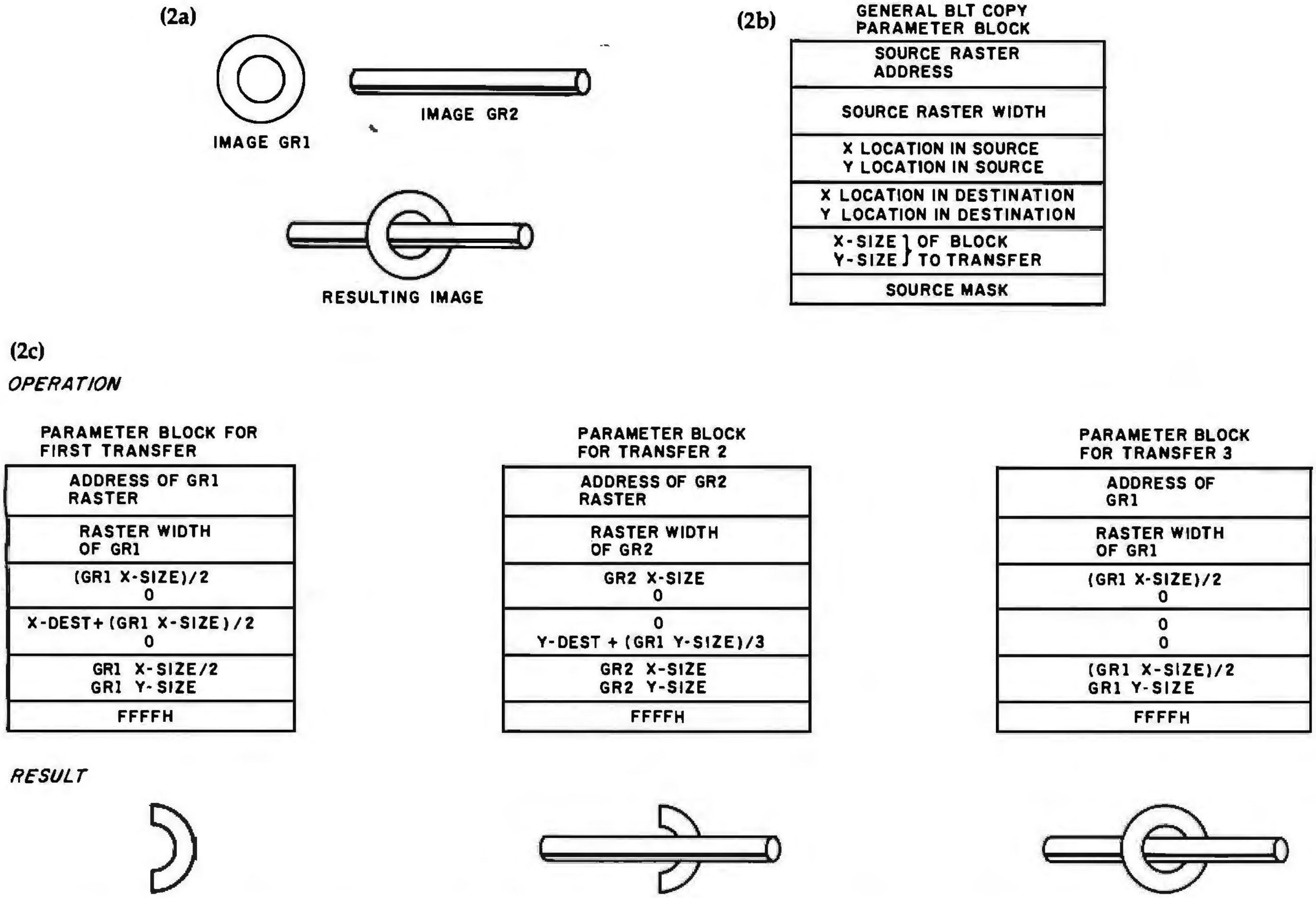

Figure 2: *Mindset graphics at work. Using the Mindset block-graphics commands, you can easily create a rod-and-ring image from its two component images (see figure 2a). Figure 2b gives the format for the parameter block of the three block transfers shown in figure 2c. The first operation in figure 2c draws the right half of the ring. The second operation superimposes the rod image. Since the transfer is done in transparent mode, the space surrounding the rod image does not replace the ring. Similarly, the third operation superimposes the left half of the ring over the rod. Some computers would have to do considerable calculations to draw these overlapping images correctly.*

break with the seemingly sacred (but annoying) IBM PC keyboard layout. Although I used the keyboard for only a few minutes, it looks like most of the changes are improvements. Note that the keypad does not double as a numeric keypad; because of this, the keyboard has no Num Lock key. The Start and Pause keys are new, returning extended key codes 133 and 134, respectively. The new Reset key resets the machine, replacing the Ctrl-Alt-Del combination on the IBM PC; it also returns the same key code (83 decimal). Also note the changed positions of the following keys: the 10 function keys, Alt, Caps Lock, the left Shift key, Backspace, the reverse slash key, Ins, Del, Pg Up, Pg Dn, Brk (Break), Scr Lk (scroll lock), Home, End, and the four cursor keys. I particularly like the placement of the cursor keys in the modified diamond configuration, which is said to be the best cursor-key layout in terms of ergonomics.

Graphics Coprocessor

The graphics coprocessor chip is a VLSI chip that takes the place of about 300 MSI (medium-scale integration) chips. Its main function is *bitblt operations*, movement of *bit*-aligned *bl*ock *t*ransfers within the video-display memory. The Mindset, like most other microcomputers, works on *bit-mapped graphics*, graphics in which the screen is composed of a rectangular array of dots and the dot array is stored in memory as a linear stream of bits, with one or more bits corresponding to one dot. Though the video display is organized as an array of bits, it is stored (in the case of the Mindset) as a sequence of 16-bit words. An arbitrary array of pixels may be stored as a sequence of partial and whole words scattered throughout memory. To move such an image on the screen, most computers must do complicated (and therefore time-consuming) calculations to locate the words that comprise the image and, when necessary, move only the bits that correspond to part of the image. The Mindset graphics coprocessor does this function in hardware rather than tie up the microprocessor, which would otherwise do it more slowly in software. In addition, the graphics coprocessor can draw arbitrary straight lines as a built-in function. Figure 2 shows how bitblt operations can simplify the drawing of a composite three-dimensional image.

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Combination Mode Number	Data Placed in Destination Area
0	source
1	AND of source and destination
2	OR of source and destination
3	XOR (exclusive OR) of source and destination
4	NOT (inverse) of source
5	AND of destination and inverted source
6	OR of destination and inverted source
7	XOR of destination and inverted source

Table 3: *Block-graphics transfer modes. The graphics coprocessor can transfer a block of graphics in eight different ways, each one substituting a different image for the destination area.*

A block-transfer operation has several options, two of which are its *transparent* and *combination* modes. Suppose that an irregularly shaped object is drawn within a rectangle of black and that this rectangle is moved to a new location. If the transparent mode is off, the image will carry its rectangle of black around with it. If transparent is on, only nonzero (non-black) pixels are transferred, and the object appears to be on top of whatever image was at the destination. This gives what I call "virtual sprites"—multicolored shapes that can be placed anywhere quickly but without the size, color, and position limitations associated with sprite-creating hardware. This simple replacement of destination pixels by source pixels is only one of eight possible combination modes. The source pixel (or its inverse) can either replace the destination pixel or be combined with it using a logical AND, OR, or XOR (exclusive OR) operation; table 3 lists these combinations and their mode numbers.

The graphics coprocessor does its operations from an internal set of microcode. Because it uses internal microcode instead of external machine code, it is very fast. Although this approach is slightly slower than another chip design that hard-wires its functions through its structure, it leaves Mindset with an interesting future option: by creating a chip with a different set of microcode, it can easily create a new graphics coprocessor chip with new capabilities.

Display Processor

The other custom VLSI chip Mindset created for its computer controls the translation of the video-display memory to some visible image on the monitor or television and other related functions. It specifies what graphics mode is in effect and how the color palette interprets each logical color (pattern stored in memory) as a physical color (shade of color as displayed on the monitor or television). As stated earlier, the Mindset can display up to 16 colors at a time, but, ironically, an RGB monitor does not give you the widest selection of colors. If you use an RGB monitor, you are limited to the 16 colors that can be produced from all 16 combinations of the red, green, blue, and intensity on/off inputs to the monitor. If, however, you are using a composite monitor or television, each of the 16 color palette definitions is defined by a 9-bit number, 3 bits each for the red, green, and blue intensities; this gives a total of 512 possible colors from which to choose.

The display processor maintains the synchronization and timing signals of the video signal, draws the colored border around the active portion of the display, and lets you shift the video image slightly to get the best view of the active display area. It also oversees the refreshing of the video display (every 1/60 second for noninterlaced modes, every 1/30 second for interlaced) and the dynamic RAM used to store the video display.

The display processor must take active control of the bus to read the video-display memory. To minimize the amount of time it does this, the designers included a 16-word buffer that the chip quickly fills, then more slowly empties while creating the actual video display.

Supervisory Processor

The supervisory processor is an Intel 8042 microprocessor that is active as long as the computer is plugged

At a Glance

Name
Mindset Personal Computer

Manufacturer
Mindset Corporation
617 North Mary
Sunnyvale, CA 94086
(408) 737-8555

Dimensions
System Unit—16 by 12.2 by 2.8 inches
Keyboard—16 by 7 by 1.5 inches
Expansion Unit—16 by 12.2 by 2.5 inches

Weight
System Unit—6 pounds
Keyboard—3 pounds
Expansion Unit—7.5 pounds with one disk drive, 11 with two disk drives

Standard Configuration
System Unit plus Expansion Unit—128K bytes of user memory, 32K bytes of screen memory, 64K bytes of system ROM, one 320K-byte 5¼-inch disk drive, keyboard, GW BASIC cartridge; see text for other configurations

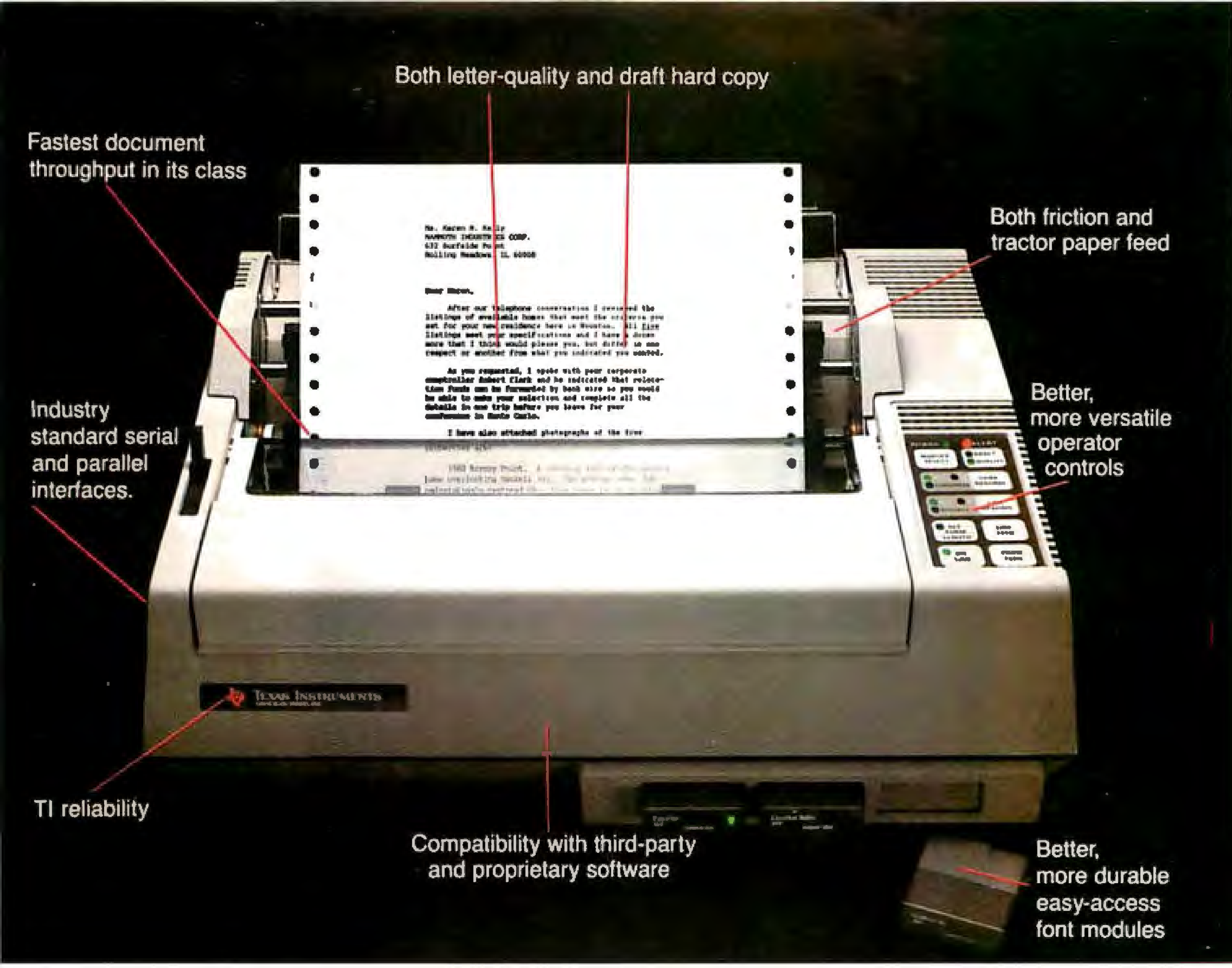
Processor
6-MHz Intel 80186 microprocessor (16-bit architecture, 16-bit data bus)

Keyboard
Detached 84-key keyboard with 6-foot coiled cable; has two sockets for optional mouse and/or Atari-style joystick

Hardware Options
Second disk drive, mouse pointing device, 128K bytes of extra memory

Software Options
Mindset MS-DOS 2.0, about $60

Prices
One-disk system (described above), about $2000; two-disk system with 256K bytes of memory, about $2600; cartridge-only system, about $1200 (prices approximate at time of writing)



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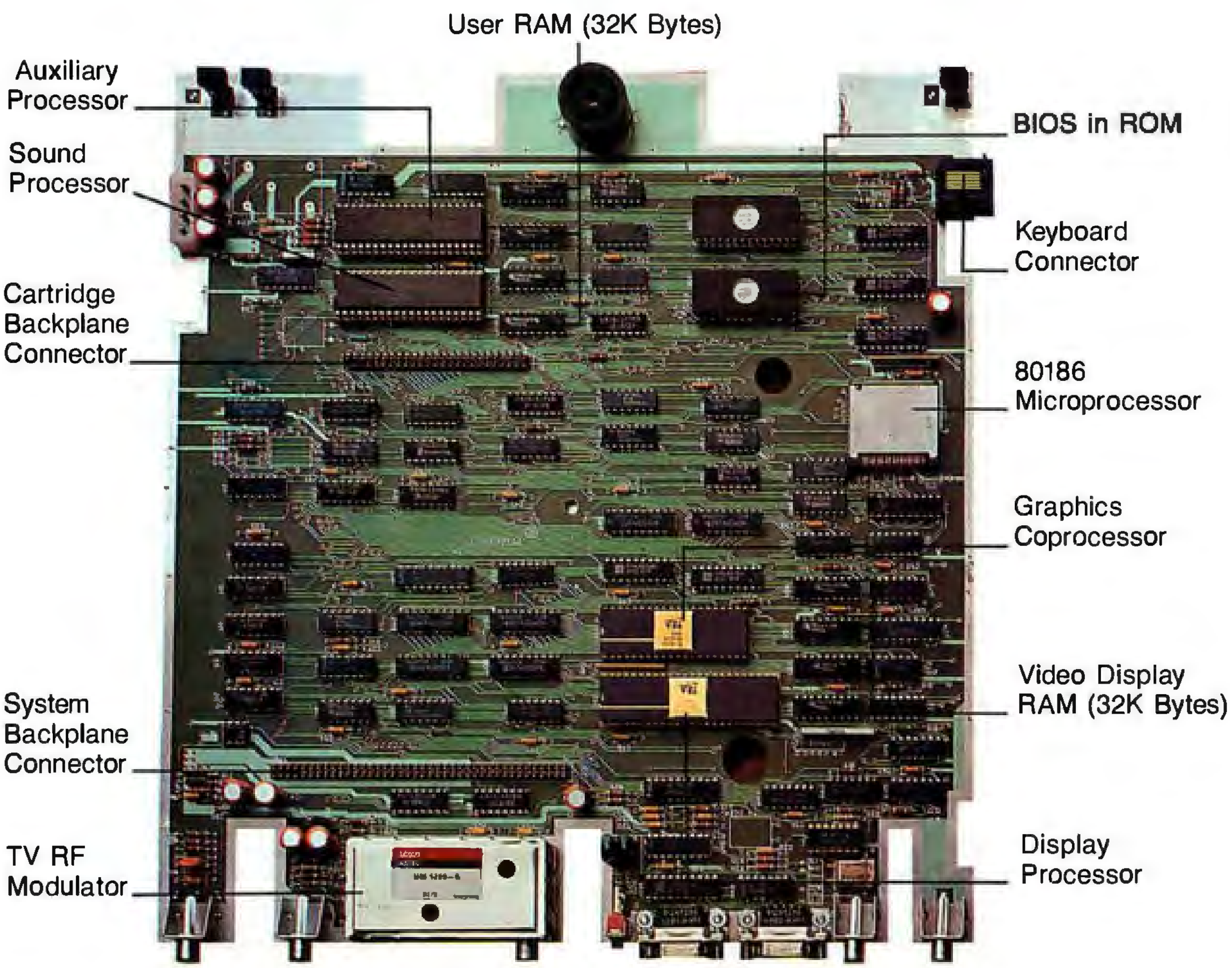


Photo 5: *The Mindset motherboard, which is a completely functional 80186-based computer.*

into an electrical outlet. It implements the Mindset clock/calendar (which is independent from the real-time clock provided for IBM PC compatibility). In addition, it receives and decodes keypresses from the keyboard and monitors "wake-up lines" from the keyboard and all I/O modules (see the section on I/O modules below). The supervisory processor, as well as other major components, can be seen in photo 5.

Cartridges

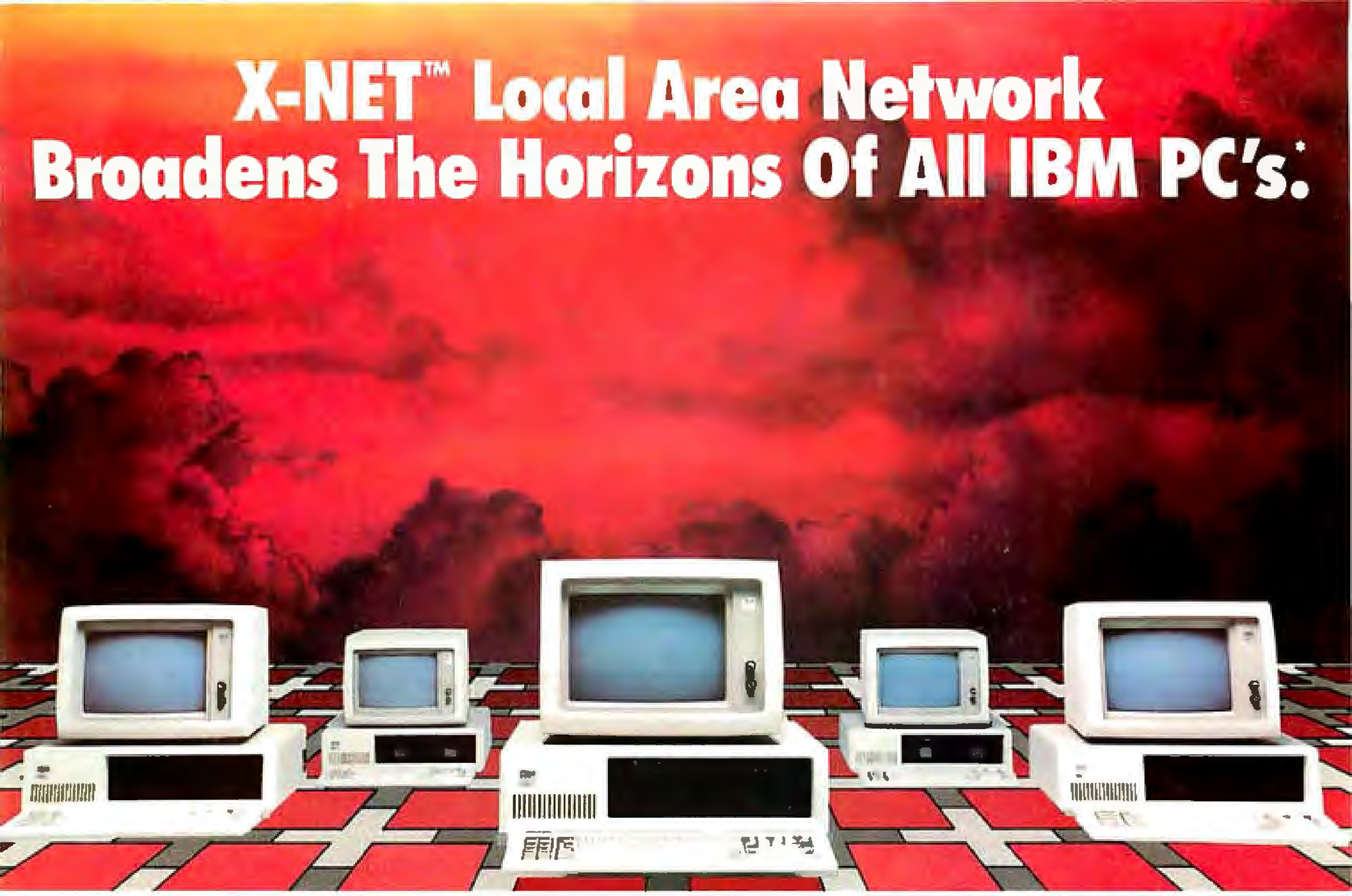
Mindset has designed three types of cartridges that can be placed into the two slots on the front of the System Unit: a cartridge can contain ROM (for programs or data), RAM (for data or extra memory) with battery backup, or a combination of both. Each cartridge has room for four 28-pin ICs; compatible ROM or RAM chips can be put in each slot, as long as the total amount of each is a multiple of 4K bytes. The cartridge mates to the System Unit via a 44-pin connector that includes 16 data lines and 15 address lines (see table 4).

The ROM cartridges can hold up to 64K bytes (using 128-kilobit ROMs or EPROMs) or 128K bytes (using 256-kilobit ROMs); later, 128K-byte EPROM (erasable programmable read-only memory) cartridges will be feasible when the cost of 256-kilobit EPROMs goes down. A ROM cartridge can store either data or, more likely, a program to be executed.

The RAM cartridges can hold up to 8K bytes of memory (up to 32K bytes when higher-capacity dynamic-RAM chips become cheaper). The memory can be used to store data (in sequential-file format) or programs. An internal battery (which is recharging whenever the cartridge is in the computer—a nice touch) keeps the contents of the memory active even when the cartridge is outside the computer; see photo 6. Most Mindset owners will find several uses for such a cartridge. It will also be important to people who buy the diskless $1200 unit, where it will replace the cassette recorder and tape as the mass-storage medium.

The RAM/ROM cartridge will have half as much of each kind of memory, 4K bytes of RAM, 32K bytes of ROM (or, later, 16K RAM, 64K ROM), and the cartridge will include battery backup for the RAM.

The first four words of every cartridge give information about its con-



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19,21,23,25,27,29,31, 32,30,28,24,12,33,38,37	bA1–bA15	Address bits 1–15
22	-bSEL1	Select 1
25	-bSEL2	Select 2
26	-bRD	Read
34	-bWR	Write
36	not connected	
39–40	+5 V	+5 volts
41	-bCPRSNT	Cartridge present
43–44	TRCKLCHG	+5-volt trickle charge

Table 4: *Signals from the Mindset cartridge connector.*

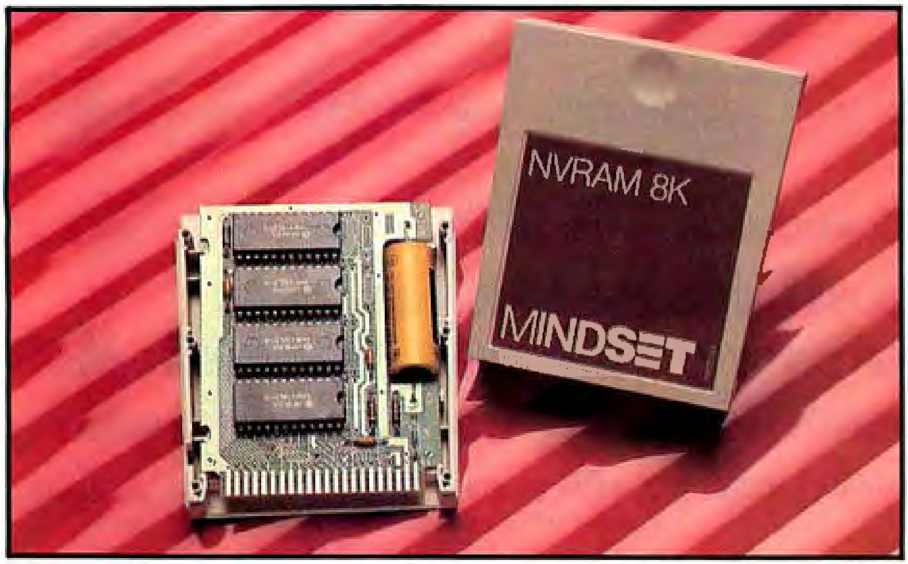

Photo 6: *The Mindset RAM cartridge with battery backup. NVRAM stands for "nonvolatile RAM."*

figuration. The first word is a cartridge identification number (used to confirm that the cartridge is meant for the Mindset computer). The second word tells whether the cartridge is structured as a sequential file, whether the memory needs to be given a wait state, and whether the cartridge is a master or slave cartridge. The third word tells how much RAM and ROM the cartridge contains. The fourth word is reserved for future use.

I/O Modules

I/O modules are Mindset's answer to the peripheral slots and cards used in Apple and IBM PC computers—like peripheral cards, they let you add extra capabilities to your computer via add-on hardware, but they are easier to handle and install. The System and Expansion units can each hold three I/O modules, the slots for which are in the rear of the machine (see photo 7a).

The I/O modules connect to either unit through a 36-pin connector that includes eight data lines (all data transfer is done a byte at a time), five address lines, and various control lines (see table 5). One such line is a "wake-up" line. This is a signal that an outside device, through the I/O module, can give to a Mindset computer that has been turned off. When the computer receives this signal, it turns itself on and begins executing a preset program. The I/O module interface also includes eight lines that constitute a device identification number. Because of this information, I/O modules do not need to be plugged into a certain I/O slot.

At the time this was written, Mindset was planning to announce the following I/O modules: a second-voice sound module (see below), an RS-232C interface, a Centronics-style parallel interface, a presentation-level-protocol (PLP) graphics receiver cartridge (for receiving videotex drawings), and both 300- and 1200-bps (bits per second) direct-connect modems. Both modems take two slots each and handle the HDLC protocol needed to do videotex. Photo 7b shows an opened RS-232C interface module.

Sound Processor

The Mindset sound processor is a simple but effective microprocessor-driven device that operates in four modes and can currently give up to six musical voices. In addition, a second sound processor can be added as an I/O module to create a stereo music synthesizer. Three of the modes give you three, four, and six musical voices, with more control on the modes that generate fewer voices. The fourth mode allows the 80186 to directly control the circuit's D/A (digital-to-analog) converters; this gives maximal control but, of course, ties up the 80186.

GW BASIC and MS-DOS 2.0

The only piece of software included with the Main Unit is a 70K-byte cartridge containing GW BASIC, an extended version of the graphics-oriented GW BASIC from Microsoft. In addition to the graphics commands supported by GW BASIC (which is itself a superset of the MBASIC supplied in most microcomputers), Mindset worked with Microsoft to include additional commands that exploit some of the computer's special graphics capabilities. All graphics commands are written to

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(7a)

(7b)

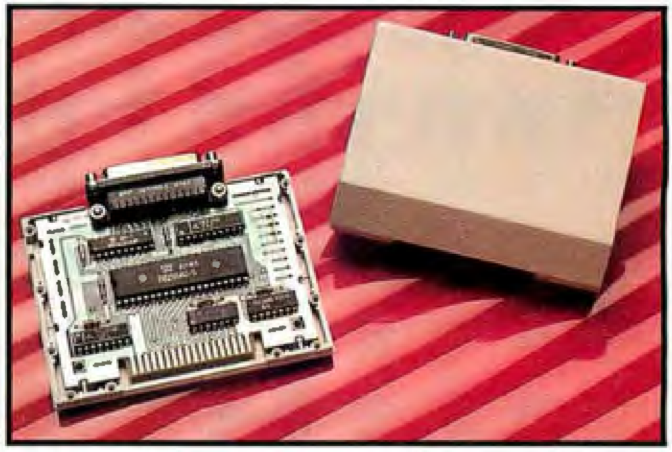

Photo 7: *Photo 7a shows the rear panels of the System Unit (bottom) and Expansion Unit (top). Each unit contains connections for three I/O modules. At the bottom left of photo 7a is a modem module (which takes two module slots). The connectors on the bottom rear of the System Unit are, from left to right, audio out, composite video out, RF-modulated video out, channel 3/channel 4 switch, RGB video out, external sync in, auxiliary serial in, and auxiliary serial out. At the bottom right of photo 7a is the RS-232C module; photo 7b shows the same module disassembled.*

make best use of the graphics functions available as BIOS calls.

Mindset GW BASIC handles rectangular images and animation as follows. A rectangular image, which I call a *view*, must first be drawn on screen; it can then be saved in a numeric array and, from there, manipulated. You can then create an *object* (which is identified by a number) as a series of one or more views. Then, with one or more GW BASIC statements, you can give the object a starting and ending location on the screen, and you can tell it how fast to move and how often to change from one view to the next. GW BASIC then keeps the image in motion *without supervision by the GW BASIC program* and automatically moves it until it reaches its destination, collides with an object, or moves outside a given rectangular boundary (you can cause a subroutine to execute at this time). In addition, objects can have their motion stopped or resumed or they can be deactivated (frozen in place and made invisible) or activated. See table 6 for a list of Mindset's graphics extensions to GW BASIC.

Mindset MS-DOS 2.0, an implementation of Microsoft's MS-DOS 2.0 tailored to make optimal use of the Mindset hardware and ROM operating system, is, like IBM's DOS, optional and does not come when you buy the Expansion Unit. It comes with an IBM-style book of documentation and will sell for about $60.

Third-Party Software

The Mindset computer will run dozens of IBM PC programs as is (see the text box "Delineating IBM PC Compatibility" on page 273 for details of incompatibility). Although its internal hardware is very different from that of the IBM PC, the design team iterated the hardware design until a selected group of popular IBM PC products worked on it. I was given a list of 41 products that had been guaranteed to run correctly on the Mindset; among them are Adventure, Word, and Multiplan (Microsoft); Condor Series 20-1 Database; dBASE II and Friday (Ashton-Tate); Deadline, Starcross, Witness, and Zork I-III (Infocom); Lotus 1-2-3; Peachtext 5000 (Peachtree Software); PFS:File, Graph, Report, and Write (Software Publishing Company); PIE Writer (Hayden Software); Spellstar, Wordstar, and Wordstar 3.3 (Micropro); Supercalc 2 and 3 (Sorcim); Visicalc and Visicalc IV (Visicorp). The list is probably longer by now, and Mindset added that "most IBM PC programs" will also run as is on the Mindset computer.

In addition, Mindset has been working closely with software companies to get enhanced products for its computer; at the time that this was written, Mindset said that approximately 25 companies were working on business, educational, personal productivity, and entertainment programs. Parker Brothers, Odesta, and Synapse are working on games, and Datasoft, Time Arts, and IMSI are working on graphics packages.

The Video Display

Graphics capabilities are at the heart of the Mindset computer, so we will look at them in more detail. As you can see from the memory map in table 7, the video-display memory starts at address B8000 hexadecimal, just as it does in the IBM PC. Whereas the IBM PC maintains 16K bytes of memory for color graphics, the Mindset computer reserves 32K bytes. With Mindset graphics modes that take 16K bytes of memory or less (see table 8), the computer can set up two areas for the video display and, at any given moment, display one of them; this is called *double buffering*. Double-buffered modes let you create glitch-free video graphics: the program alternates between showing the two buffers, always drawing the new image on the buffer not visible.

You will need a special monitor with a high-persistence phosphor to use the two interlaced graphics modes, modes 5 and 6. All the other modes are *noninterlaced*—that is, the entire video image is redrawn every 1/60 second. In the two interlaced modes, the image is drawn in two 1/60-second passes—the first draws all the even scan lines, and the second fills in all the odd scan lines. This means that each scan line is redrawn every 1/30 second. The human eye can detect 30-Hz flickering but not 60

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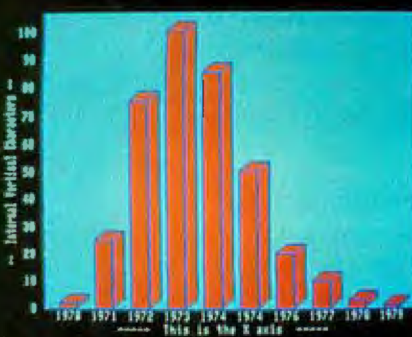

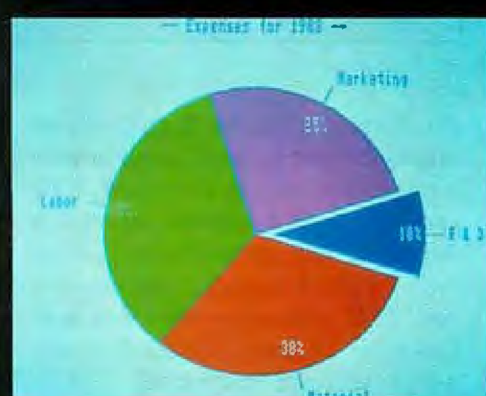

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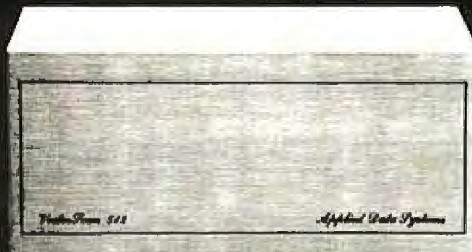

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Circle 36 on inquiry card.

Pin	Name	Function	Pin	Name	Function
1–2	GND	Ground	25	RESET	Reset
3–4	+5 V	+5 volts	26	CLK0	Clock 0
5	+12 V	+12 volts	27	CLK1	Clock 1
6	−12 V	−12 volts	28	MODRDY	Module ready
7	TRCKLCHG	+5-volt trickle charge	29	MODIRQ	Module interrupt request
8	LRESET	Long reset	30	-MODID	Module ID enable
9–16	D0–D7	Data bit 0–7	31	-WAKE-UP	Wake-up
17–21	A1–A5	Address bit 1–5	32	AUDIO IN	Audio in
22	-RD	Read	33	AUDIO OUT	Audio out
23	-WR	Write	34	SYSCLK	System clock
24	-MODSELX	Module select x	35–36	GND	Ground

Table 5: *Signals from the Mindset I/O module connector.*

BASIC statement	Function
DIM OBJECT BALL1(15,20)	Defines BALL as a numeric array large enough to hold a 15- by 20-pixel view
DEF OBJECT 3 AS BALL1,BALL2,BALL3	Defines a numbered object as a series of one or more views
OBJECT 3,1 = 10,2 = 50	Positions object 3 at screen location (10,50); this statement can set any or all of 10 parameters: beginning, ending, and offset *X* and *Y* locations, how long each view will be displayed, object transparency, the number of the current view, and the speed of movement
SPD = OBJECT(3,10)	Returns the current speed (parameter 10) of object 3
ACTIVATE 2,3,5	Restores animation of objects 2, 3, and 5
DEACTIVATE 3,4	Freezes objects 3 and 4 and makes them invisible
START 1	Restores motion to object 1
STOP 1	Stops all motion in object 1 but leaves it visible
COL2 = COLLISION(2)	Determines if object 2 has collided with anything
COL23 = COLLISION(2,3)	Determines if objects 2 and 3 have collided with each other
ON COLLISION 2,3 GOSUB 20000	Performs the subroutine at line 20000 if objects 2 and 3 have collided
COLLISION ON/OFF/STOP	Resumes, ends, or suspends reporting of object collisions in general
CL2 = CLIP(2)	Determines if computer tries to draw object 2 outside the clipping rectangle
ON CLIP 2 GOSUB 20000	Performs the subroutine at line 20000 if computer tries to draw object 2 outside the clipping rectangle
CLIP ON/OFF/STOP	Resumes, ends, or suspends reporting of object clipping in general
AR23 = ARRIVAL(2)	Determines if object 2 has arrived at its destination
ON ARRIVAL 2 GOSUB 20000	Performs the subroutine at line 20000 if object 2 has arrived at its destination
ARRIVAL ON/OFF/STOP	Resumes, ends, or suspends reporting of object arrivals in general

Table 6: *Animation extensions to Mindset GW BASIC.*

Hz; therefore, modes 5 and 6 flicker unless you use a special monitor with a phosphor whose glow lasts long enough to still be visible when it is refreshed 1/30 second later. All the mode 5 and 6 images I saw on normal RGB and composite monitors flickered; therefore, I doubt many people will use this mode.

When the system is in a graphics mode, you can make it generate an interrupt at the end of any scan line. The system defaults to generating this interrupt at the beginning of *vertical blanking*, the time between the drawing of the last line of active video and the first active-video line of the next frame. The vertical-blanking interval lasts about 4 milliseconds (ms) and is used by the system to update the video-display memory while it is not being used for display (to prevent visual glitches from appearing on the screen). The interrupt thus generated is called the *VBLANK* interrupt. You can modify, replace, or add to the system VBLANK interrupt routine, thus allowing you to modify the video display (and do other things) on the fly—that is, while the display is being drawn. (The Atari home computers also use scan-line and VBLANK interrupts heavily.)

Also, as you can see from figure 1, the Mindset computer allows several video input and output options. The


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Memory Location (Hexadecimal)	Length in Kilobytes	Function
0–07FFF	32	32K bytes of on-board RAM
08000–3FFFF	224	224K-byte slot for expansion RAM
40000–7FFFF	256	Reserved
80000–8FFFF	64	Cartridge slot 1, first half
90000–9FFFF	64	Cartridge slot 1, second half
A0000–B7FFF	96	Reserved
B8000–BFFFF	32	32,000 bytes of video-display memory followed by 768 bytes reserved by Mindset for unspecified use
C0000–CFFFF	64	Cartridge slot 2, first half
D0000–DFFFF	64	Cartridge slot 2, second half
E0000–F7FFF	96	Reserved
F8000–FFFFF	32	32K bytes for ROM-based operating system

Table 7: *The Mindset memory map.*

Screen Resolution (Pixels)	Number of Colors	Double-Buffering?	Mindset Mode Number	IBM PC Mode Name
160 by 100	16	no	NA	low-resolution
300 by 200	2	yes	0	NA
300 by 200	4	yes	1	medium-resolution
320 by 200	16	no	2	NA
640 by 200	2	yes	3	high-resolution
640 by 200	4	no	4	NA
320 by 400 (interlaced)	4	no	5	NA
640 by 400 (interlaced)	2	no	6	NA

Table 8: *A comparison of IBM PC and Mindset graphics modes. Modes are noninterlaced unless otherwise marked. NA means "not available" for a given computer.*

area. Other write-mask values can be used to limit or modify the bitblt operation taking place.

The *collision mask* is an *n*-bit mask (where *n* is the number of bits needed to represent a pixel in the current graphics mode) that defines what a collision is when a bitblt operation is performed. A collision is said to occur when the logical AND of the destination pattern and the write mask matches the value of the collision mask. (This situation is further modified by a "don't-care" mask that signals a collision when only certain specified bits match.) As noted below, a collision can cause the computer to execute a user-defined interrupt routine.

You can optionally define a *clipping rectangle* with a single BIOS call. Once a clipping rectangle is defined, no bitblt operation can change any area outside that rectangle; *clipping* is said to occur when the graphics coprocessor detects an attempted change outside the clipping rectangle. The clipping rectangle can be used for many things, from the creation of window-based software to protecting nonvideo-display memory from graphics commands.

You can establish which events will cause an interrupt (collision, clipping, the completion of an operation by the graphics coprocessor, or any combination) and specify the address of the interrupt routine. Although one routine must service as many as three conditions, the AH register holds a value that tells the interrupt routine which single condition caused the current interrupt. The interrupt-on-task-done is useful when you remember that the graphics coprocessor can work independently of the 80186. You might use such an interrupt routine to service a queue of graphics tasks, the first of which would be given to the graphics coprocessor as soon as the latter indicates it is free.

Finally, one bitblt operation deals with placing text within a destination buffer. Unlike many computers, the Mindset computer is always in graphics mode, and normally each character would have to draw alphanumeric characters a bit at a time.

computer has separate output jacks for composite, RGB, and RF-modulated video; these are outputs to a composite monitor, an RGB monitor, and an ordinary television set, respectively. In addition, the Mindset allows the video signal to be driven by an external video synchronization signal. If some colors in the color palette are defined as being keyed to external video, the computer video output can be combined with an external video signal; this allows the external image (from, say, a video camera or laser disk) to replace the area of the display where the keyed color would have appeared.

Bitblt Operations

Bitblts are, as I said before, bit-aligned block transfers—that is, operations that work on rectangular areas of video-display memory. Also mentioned were the transparent and combination modes that affect bitblt operations. They can also be affected by several other modifiers: the write mask, the collision mask, the clipping rectangle, and the user-defined collision/clip/task-done interrupt routine.

The *write mask* is a 16-bit mask that is consulted whenever a word in the destination area is about to be altered; only bits in the destination word corresponding to bits that are 1 in the write mask can be altered. A write mask of FF hexadecimal allows the bitblt operation to proceed normally (all bits are 1s), while a write mask of 0 forces the computer to make no changes to the destination

Fortunately, the BIOS includes a routine that writes a string to the destination buffer given the string, the character font to be used, and the location and orientation (left, right, up, down) of the string. If you do not use the default font built into the computer, you can define your own—your font can be proportional or fixed-width and can be any number of pixels wide and high. The ability to use any number of character fonts of any size is a very nice feature.

Documentation

The Mindset System Unit will come with the *GW BASIC Reference Manual* and *Operation Guide for the Mindset Personal Computer*, both in the 3-ring-binder-and-slipcover size and format made popular by IBM PC documentation. The Expansion Unit, Mindset MS-DOS 2.0, and other Mindset products will come with documentation sections to be added to the *Operation Guide*. In addition, Mindset will be offering its Programmer's Reference Library for software developers at a price of about $70. This will include an 8086 macro assembler on disk, a *Programmer's Reference Guide* (to explain DOS), and a *Technical User's Guide* (to explain the Mindset system). This is a particularly good buy (the macro assembler, if it's any good, is worth double that price) and shows Mindset's commitment to encouraging third-party software.

Distribution, Dealer Training, and Warranty

A spokesperson from Mindset said that it was putting together a network of dealers consisting of "full-service computer retailers," including "major chains" of computer stores. The dealers would also be authorized repair centers. Dealers would receive both in-person and videotape training to sell the Mindset; the spokesperson offered no details on these subjects. The computer's warranty will be for 90 days, including all parts and labor.

Caveats

This product preview was conducted after three days at Mindset

Animation and the Mindset

by the Mindset Design Team

We all know that movies and cartoons are a series of still pictures flashing by to give the illusion of motion. Children still play with the little books that they can "page flip" to produce a few seconds of animated movement. Those little books give a quick idea of the problem of the animator, whether doing cartoons or computer graphics. An hour of action takes 43,200 pictures at an animation rate of 12 frames a second, the minimum acceptable rate. If each image takes 32,000 bytes, we need storage for 1,382,400,000 bytes. Just as a cartoonist would not draw 43,200 images, neither would a computer animator keep more than a gigabyte of images on line. The Mindset contains special hardware that eases the job of animation in real time; these features both simplify and speed up the process. In many ways, it is a fast and enhanced form of cel animation.

Cel animation is a classic technique using sheets of transparent celluloid (called cels) with only part of the image drawn on each cel. As an example, take a simple scene of a dog running past a house. First, the background cel with the house is drawn. Next, a cel with the dog's body is placed over the first cel. Finally, the tail and legs are laid down with the final cel, and the composite cel is photographed. The top two cels are removed, the body laid down again but moved a little over, the new positions of the legs and tail are added, the composite cel is photographed, and so on. Cel animation is detailed and exacting work with a practical limit of about seven cel layers.

The Mindset graphics coprocessor offers all the techniques of cel animation and more. It is a special 16-bit microprocessor with the complexity of an 8086 but optimized to move and manipulate images. Each image is stored as a raster (or pixel array) of whatever size (up to 64K bytes) appropriate for that image. When moving the house, for example, onto the display, you tell the graphics coprocessor the size of the house image (which is, say, 40 by 87 pixels) and the destination area (which is, say, 320 by 200) and which pixel in the destination to move to.

An obvious advantage of the cel is that it overlays only what is painted on it. It is transparent where it is not painted. The Mindset graphics coprocessor can be told to regard all zero pixels as transparent so that they will not affect the destination raster. If the house is surrounded by zero pixels, it will overlay the scene, just as in cel animation. The Mindset, of course, does not care how many cels overlay a scene. Beyond this, the graphics coprocessor permits all logical bit operations. Also, you can specify the logical NOT of either raster. This leads to many special operations, including bit planes, fade-in and dissolve of images, striping, color changes, etc. Clipping bounds can be specified so that an image can be easily made to disappear through a doorway and a Times Square sign effect is trivial.

A computer display is rewritten every 1/60 second. Changing part of the image will cause flicker if it occurs during the video display. The Mindset provides an interrupt to synchronize writing of the image with the display. There still comes a time when there is more to write than time allows. The Mindset has modes for double buffering of images so that page flipping can be used. At the slowest rate that produces acceptable animation, this gives almost five frames to change the image in the buffer not being shown and then to "flip" the pointer just before the fifth frame.

Power and function are obvious traits of the Mindset, but neither of them are any use if the machine isn't fast. The Mindset architecture has been designed with speed in mind. The graphics coprocessor and the display processor are on a separate graphics bus and have priority access to the video-display memory (the frame buffer). The graphics coprocessor and the 80186 work in parallel as long as the 80186 is not addressing the frame buffer while the graphics coprocessor is trying to run, or as long as the graphics coprocessor is not addressing main memory while the 80186 is. In effect, a lot of the display can be built by the graphics coprocessor while the 80186 is doing other useful things.

The Mindset achieves its animation speed and function through parallel processing and special processors optimized to move and manipulate pixels. Conceptually, it is the next logical step in cel animation and creativity tools.

Circle 334 on inquiry card.

Glossary

bitblt: *short for "bit block transfer." The steps required to move an array of pixels from one area in computer memory to another area.*

color palette: *an array in memory that contains the digital representations of the colors to be displayed on the screen.*

frame buffer: *the area of memory that contains all the pixels to be displayed on the screen. The frame-buffer size in bytes is determined by the equation*

$$\frac{\text{\# of bits/pixel}}{8} \times \text{pixels per scan line} \times \text{\# of scan lines}$$

Also referred to as "video-display memory."

object: *exists within a raster as a rectangular array of pixels.*

pixel: *short for "picture element." The smallest element of the display area. Each pixel is represented by a number of bits in memory.*

raster: *a word-aligned rectangular array of pixels (n words in width by m scan lines in height).*

raster op: *the operation used to modify pixel values during a bitblt.*

scan line: *one horizontal display line of pixels on a screen.*

v-blank: *the amount of time required for the cathode-ray display to retrace from the end of the last scan line in one frame to the start of the first scan line in the next frame (approximately 16 ms).*

(less than two months before the product announcement), subsequent telephone calls to its technical people, and study of several technical documents. When I was at Mindset, I saw two breadboarded prototypes (using discrete ICs instead of the custom chips) and one preproduction unit (with custom chips and printed-circuit boards). I did not see GW BASIC. Although I saw several impressive demonstration programs, I saw no commercially available software meant to use Mindset graphics, either from Mindset or third-party vendors. The only documentation I saw was an internal document that will probably be part of the Programmer's Development Library; the document was clear and well organized. My only hands-on experience with the computer was less than an hour with a rudimentary in-house drawing program called Ida.

Commentary

If Apple had put this product out (and done it as well as it did the Macintosh), this computer would have become the next Apple II and dominated the under-$5000 market. However, a new company like Mindset does not have the industry and consumer recognition of Apple and IBM, and, for reasons that have nothing to do with product quality, Mindset's computer may not achieve as large a share of the market as it would have as part of an established company and product line.

This product looks solid, and the company has made more right decisions than most new companies. I like the design (enough IBM PC compatibility to be useful plus superior hardware), the custom chips (which demonstrate a significant jump in the performance/price ratio, even more than the Apple Macintosh), and the early and enthusiastic support of third-party software vendors.

My reservations come from the things I *didn't* see less than two months before the product announcement (documentation, finished software, GW BASIC, and marketing details), the closed-hardware architecture, and the lack of follow-through in developing the potential of the product. The last two points need further elaboration.

By choosing a closed-hardware architecture over an open one (i.e., by deciding to keep hardware details secret), Mindset has forced software developers to create software that will be compatible with future versions of the Mindset hardware. This lets

Mindset make small revisions to its product's hardware and software without having to worry about compatibility problems with existing software and hardware; it also allows the company to create more powerful computers in the future that can be upward compatible with existing Mindset-based software.

On the negative side, the closed-hardware policy prevents the establishment of a large volume of third-party hardware, such as that developed for the Apple II and IBM PC families (a factor that has contributed significantly to their continued success), and forces users to depend on Mindset as the sole vendor of I/O modules. (The one exception to this is that software developers will be told enough to create software cartridges.) In the past, a closed-hardware policy has not prevented companies from reverse-engineering the hardware to make new products, and it has ultimately had a significant negative effect on the popularity of the machine in question. I don't see any reason why this case should be any different.

By saying that Mindset has not followed through on its product, I am only expressing my opinion that it should do something that it has decided not to (perhaps for no worse reason than lack of resources, a very real limitation). I was far more impressed upon first seeing the Apple Macintosh, even though it and the Mindset are equally important in terms of hardware. This leads me to believe that microcomputers are most effective when they are conceived and implemented with a single unifying vision. Apple did this; Mindset did not. Its vision of creating a powerful, graphics-oriented computer for around $2000 comes through very strongly. However, by not dealing with the issue of what jobs this computer can uniquely do and creating the appropriate software, the company has caused its computer to stand out less than it deserves to. The unity of Apple's vision (embodied primarily in the Macintosh's strong software design) ultimately makes its computer more interesting than the Mindset. As it stands, the Mindset is just another computer with more power but no new applications it can be used for; with the right software, it could easily eclipse anything now on the market.

Conclusions

The Mindset sets a new record in the price/performance ratio of a microcomputer, bringing most of the speed and function of a $50,000 graphics minicomputer to a machine almost 1/20 the cost. If the computer is delivered as described and has a sufficiently high level of IBM compatibility, it promises to be an extremely attractive alternative to the IBM PC that, while paying tribute to a PC-driven market, breaks the hammerlock that PC-compatibility-mania has placed on technical innovation in the microcomputer marketplace. ■

Gregg Williams is a senior technical editor at BYTE.

Circle 341 on inquiry card.

89.6% chose ScratchPad Plus over Multiplan, Visicalc IV and Supercalc 2.

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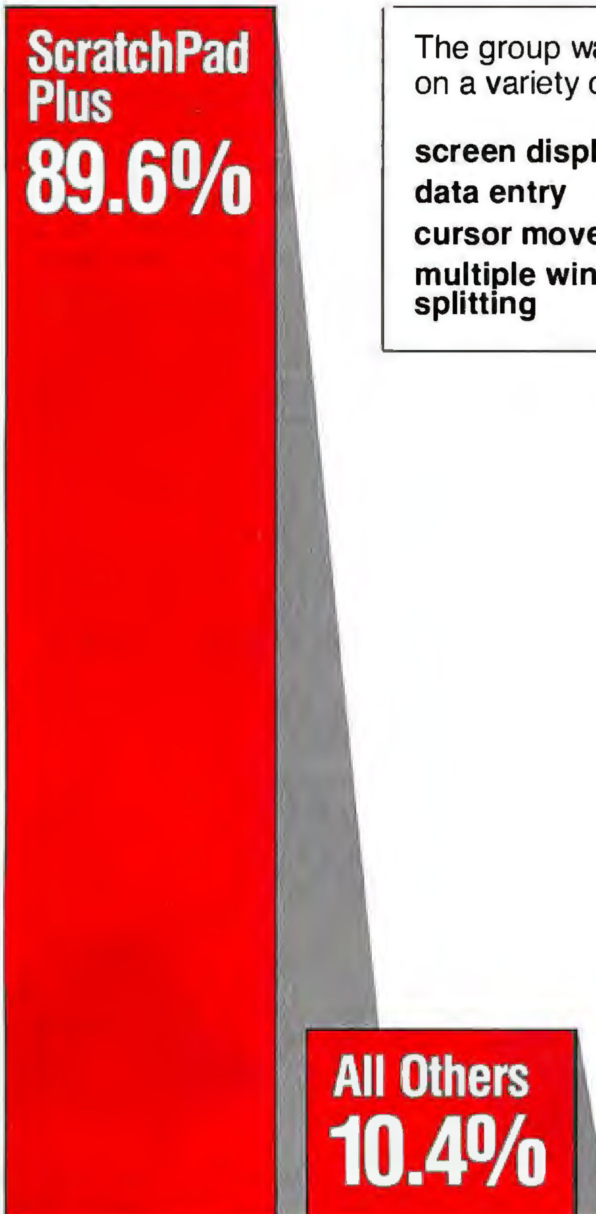

The group was asked to rate the four spreadsheets on a variety of features, including:

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virtual memory
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long strings
cell locations
and many other features

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BASIC COMPILER

Compatible with Microsoft BASIC

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Greater accuracy with BCD math routines

If you have used other languages without BCD math, you know how disconcerting decimal round off errors can be. For example:

With IBM PC* BASIC	With SuperSoft BASIC with BCD math
10 A=.99	10 A=.99
20 PRINT A	20 PRINT A
30 END	30 END
Output: .9899999	Output: .99

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SuperSoft's BASIC is a true native code compiler, not an intermediate code interpreter. It is a superset of standard BASIC, supporting numerous extensions to the language. Important features include:

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*SuperSoft BASIC is compatible with Microsoft BASIC interpreter and IBM PC BASIC. Due to version differences and inherent differences in compilers and interpreters some minor variations may be found. Machine dependent commands may not be supported. The vast majority of programs will run with no changes.

Is BASIC Getting Better?

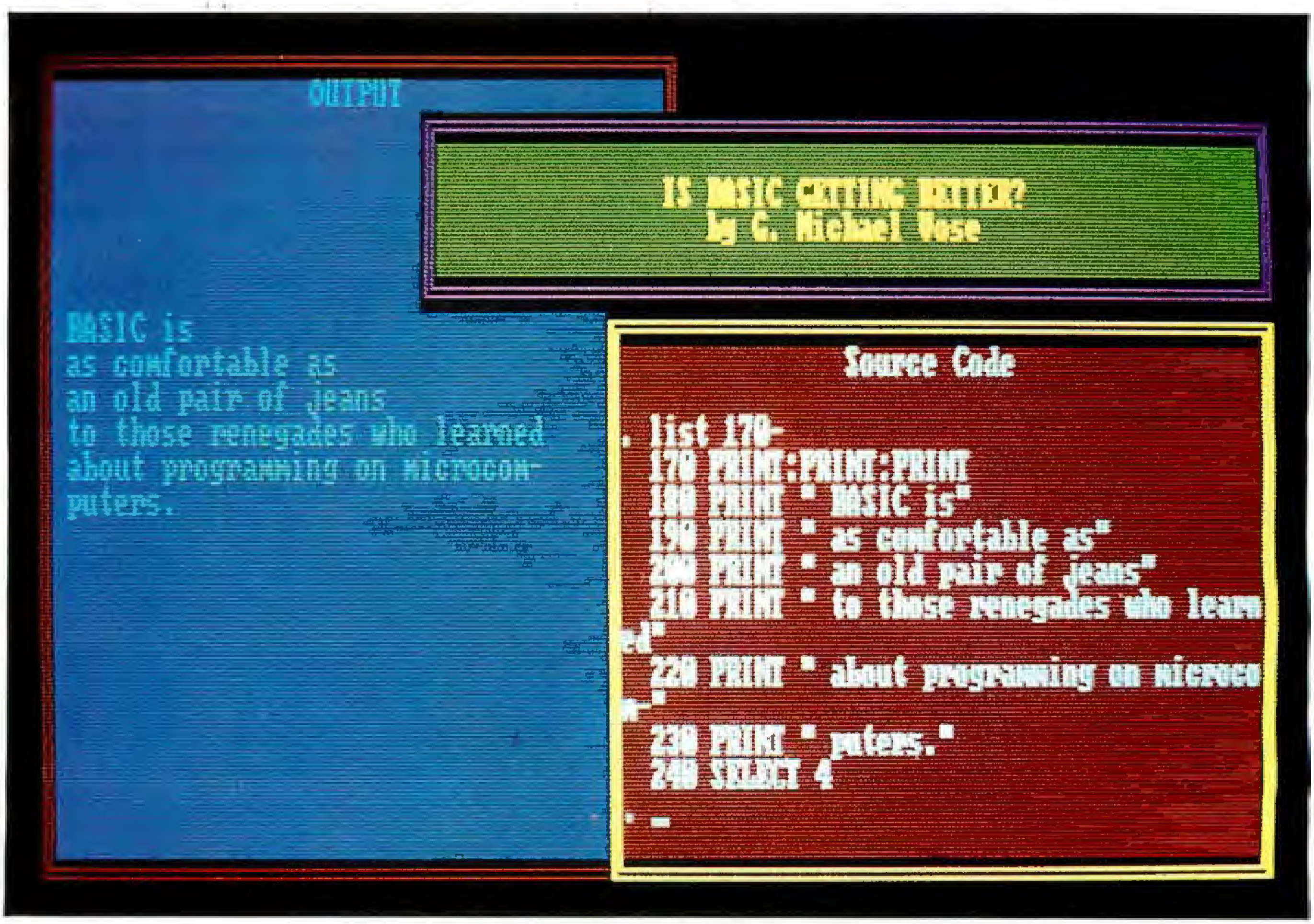
The language that made early microcomputers accessible is maturing to match the sophistication of a new generation of hardware

G. Michael Vose
BYTE Senior Technical Editor

BASIC is as comfortable as an old pair of jeans to those renegades who learned programming on microcomputers. On many early microcomputers, BASIC was more than a language—it was also the operating system of the machine, the interface between the electronics inside the beast and the gawk-eyed neophyte at the keyboard.

Learning to program in BASIC was thrilling. The first time you printed out your name 100 times with the help of a FOR. . .NEXT loop you experienced a rush comparable to serving an ace on the tennis court or hitting a 280-yard tee shot. Figuring out a sorting algorithm was akin to getting an A on an algebra final or getting a kiss from your first sweetheart.

In the last eight years, microcomputers have grown up, matured from 1K- and 2K-byte user memory, cassette-based novelties into 256K-byte, 16-bit microprocessor-based powerhouses. The language of microcomputers has evolved, too, through Pascal and FORTH, to C and Modula-2. BASIC hasn't stood still in the intervening years—the text box "A



Brief History of Microsoft Basic" chronicles the evolution of Microsoft BASIC (MBASIC), the de facto industry standard for BASIC since its creation in 1974.

But is it fair to ask in 1984, a watershed year in the history of the information age, is BASIC getting any better? Has the language kept up with the needs of the programmers who use it? Has it kept pace with the Wizard of Oz machines it runs on?

The following pages will describe several significant new developments on the BASIC frontier. BYTE presents a look at five recent versions of BASIC that purport to improve on the Microsoft standard. These examinations are not reviews—three of the products have not been released as of this writing—nor do they compare the BASICs in question to one another. Instead, we offer descriptions of these new BASICs with an eye toward answering the question headlined above—is BASIC getting better?

These products collectively show several important trends for BASIC, including: a move away from interpreters to compilers; an emphasis on built-in program-development tools; and, in the newest products, a multiple-window environment for creating programs, offering the ability to view source code and its output simultaneously.

Interestingly, the new BASICs recognize the need for an interactive environment for BASIC (that's part of what makes BASIC attractive as a tool for learning to program computers) and they avoid traditional compilers. A new class of compiler, the incremental compiler, has found favor among BASIC's recent innovators. This compiler permits the simulation of interactivity, provides another level of error checking, and would, by itself, be a significant improvement to BASIC.

But the new BASICs provide even more: user-defined procedures and functions, called by name; named subroutines; unlimited variable and label names; alternate screens for looking at source code, providing variable cross-reference tables, and examining output; and support of large user memory, math-coprocessors, and sophisticated graphics.

The first of the BASICs we'll look at is BetterBASIC, a product from a Massachusetts-based start-up firm called Summit Software Technology. Next, Scot Kamins examines the new Macintosh BASIC, a language developed to take advantage of the powerful new Apple computer (see "The Apple Macintosh Computer," by Gregg Williams, February 1984, page 30). Then, Don George investigates Professional BASIC from Morgan Computing Company Inc., of Dallas, Texas. On page 344, Brian Capouch explores the BASIC-09 language that runs on MC6809 microprocessor-based machines using the OS-9 operating system.

The recent announcement of a new version of BASIC by a company founded by BASIC's original authors, John Kemeny and Thomas Kurtz, prompts the text box "True BASIC" on page 300. Little concrete information was available about this product at the time of this report, and the claims of the text box's author, Brig Elliott (vice-president of True BASIC Inc.), could not be verified. But this announcement warrants attention because of the reputation of the principals involved in the effort.

The evolution of a standard for the BASIC language is mired in the complicated bureaucratic process required by the American National Standards Institute (ANSI). While a standard has been proposed, there is a lesson to be learned from the innovation that has been taking place in the absence of a standard: new products try to emulate what the market has determined to be a standard. In the case of BASIC, that standard is the Microsoft version. The following pages will show that you can improve on a standard while not getting too far away from it.■

G. Michael Vose is features editor for BYTE. He can be reached at POB 372, Hancock, NH 03449.

A Brief History of Microsoft BASIC

Microsoft BASIC (MBASIC) is an industry standard for BASIC languages simply because it was the first—and for many years the only—version of BASIC available for microcomputers. MBASIC introduced a new generation of programmers to the esoteric art of writing instructions for computers.

The first microcomputer BASIC interpreter was written in 1974 by Paul Allen and Bill Gates on a PDP-8 minicomputer for an Intel 8080 microprocessor emulator. This project was an outgrowth of college work in computer science and freelance programming activity, and it explored the feasibility of producing a language product for the then new devices being marketed by Micro Instrumentation and Telemetry Systems (MITS). These machines were called microcomputers, the first of which was named the Altair 8800. This early BASIC interpreter required 4K bytes of RAM (random-access read/write memory) and was crude by today's standards.

MITS licensed the Gates/Allen BASIC for the Altair in late 1975, and Microsoft was born. By the end of 1976, over 10,000 Altairs had been sold with either the 4K-byte or the 8K-byte MBASIC. The fledgling company's work on an expanded version of the language using 8K bytes of RAM was spurred by a new machine under development by the office-machine company, Commodore Ltd. The Commodore PET debuted in mid-1976 with a licensed version of the 8K-byte MBASIC. Commodore's license was long-term and permitted alterations to the code supplied by Microsoft. Commodore has since modified this early version of 8K-byte MBASIC to produce its own versions of PET, VIC-20, and C-64 BASIC rather than going back to Microsoft for upgrades.

This early version of 8K-byte MBASIC is commonly referred to as version 2.0, the 4K-byte version is 1.0. In early 1978, Microsoft sold a license to Tandy Corporation for the TRS-80 Model I. This machine initially used a BASIC written in house, called Level I BASIC, a limited product that soon gave way to Level II, or MBASIC version 2.0. At the same time, the company licensed version 2.0 to another recent entry into the computer business, a West Coast-based garage operation dubbed Apple Computer Inc.

By early 1979, a new version of the language was under development. Version 3.0 of MBASIC provided extended functions for program development (TRACE, AUTO, etc.) plus graphics and sound commands. These enhancements were made to comply with the requests of potential new licensees who wanted software that showed off the newest hardware capabilities.

Microsoft claims an installed base of two million; Digital Research claims a like amount for CP/M.

On the heels of version 3.0 came a version of MBASIC that supported floppy-disk drives. Known in house as version 4.0, the rest of the world called it Disk BASIC and its popularity spread quickly.

Late 1980 brought IBM and Microsoft together, an event that catapulted Microsoft into a leadership position in the microcomputer-software industry. Working with Seattle Computer, Microsoft created version 5.0, or GW (Gee Whiz) BASIC. Version 5.0, finally released in late 1981, was designed to take advantage of 16-bit processor environments and added many enhancements for sophisticated color graphics, windows and ports, music, softkeys, and other features.

Microsoft claims an installed base of 2 million machines licensed to run the various versions of its BASIC interpreter. This claim is conservative at best. Digital Research, Microsoft's major competitor in operating systems and language products, claims a like number of CP/M installations. It is likely that there are a substantial number of machines running MBASIC that don't use CP/M but that there are a much lower number for the reverse case.

True BASIC

Brig Elliott
True BASIC Inc.

Twenty years after inventing the BASIC language, Professors John G. Kemeny and Thomas E. Kurtz have teamed up again to develop a powerful and portable version of the new ANSI American National Standard BASIC. (For information on the proposed standard for the BASIC language, see "On the Way to Standard BASIC" by Thomas Kurtz, June 1982 BYTE, page 182, and "The Proposed ANSI BASIC Standard," by Ronald Anderson, February 1983 BYTE, page 194.)

Kemeny and Kurtz have started True BASIC Inc., and the company's first major product is a new version of the BASIC computer language called, appropriately, True BASIC. True BASIC's design goals are portability, power, ease of use, and speed.

The initial version of True BASIC will run on the IBM PC and PCjr, but its implementors will produce versions for other major microcomputers during the coming year. They estimate a three-month conversion process for each new machine.

The True BASIC system consists of a modern version of BASIC with good control structures, graphics, and file handling; an integrated screen editor; and helpful utility programs such as formatters and variable cross-reference generators.

The True BASIC Language

The True BASIC language is based on the proposed ANSI American National Standard, which has been in preparation since 1974. Tom Kurtz, a founder of True BASIC Inc., was chairman of the ANSI committee defining BASIC during this time. True BASIC has slimmed down the language from the proposed standard by removing clutter and features few programmers use but it has kept and enhanced the powerful core of the language.

In a nutshell, the True BASIC language has all the convenience of older BASICs, but has added many features to let programmers build large, complicated programs. These features include modern control structures, machine-independent raster graphics, separately compiled functions and procedures, error trapping, several types of files, double-precision floating-

point numbers, and built-in matrix manipulation.

Many of these capabilities have never before been available on microcomputers. But microcomputers have grown enough so that True BASIC can offer features seldom found even on mainframes.

A particular point of pride for the True BASIC team is that the language will handle enormous amounts of memory. Most microcomputer languages currently available have difficulty accessing more than 64K or 128K bytes of memory. Because memory sizes can grow into the megabytes, this is too restrictive. True BASIC allows objects (strings, arrays, etc.) to be very large—the only practical limit is the amount of memory in a given machine. In fact, True BASIC is targeted for machines with at least 128K bytes of memory, though a stripped-down version for 64K bytes may be available.

Truly Portable Programs

Programs written in True BASIC will be truly portable. The True BASIC language is implemented as a portable compiler with run-time routines; only a small section of the code needs to be rewritten to bring the language up on a new machine. Programs written in True BASIC, therefore, will be able to run without change on any of the microcomputers for which compilers exist.

True BASIC Inc.'s president, Christian Walker, points out that graphics have long been the scourge of transportable programs. "There used to be no way you could get a BASIC program to draw pictures on both the Apple and the IBM PC," he comments. But programs written in True BASIC don't access the screen in terms of pixels or screen images—they plot their results in terms of "problem coordinates" that automatically translate to work on any machine that supports the True BASIC system.

True BASIC is implemented by a compiler that compiles code for an interpreter. Proprietary compilation techniques make the code run much faster than existing interpreter versions of BASIC. True BASIC programs will execute as fast as, or faster, than programs written in some compiled BASICs.

Dazzling Graphics

One major strength of the early versions of BASIC was how easy they made it to print numbers. The complicated format statements used by FORTRAN were all eliminated. True BASIC makes it just as easy to get graphic output—points, lines, polygons, graphs, and so forth.

Gone are the days of tediously counting pixels on the screen and doing complicated arithmetic to figure out where to put lines. All plotting in True BASIC is done in terms of "problem coordinates"; if you want to plot millions of tons of potatoes versus years, you do all your plotting in terms of these coordinates. True BASIC automatically maps these coordinates to the screen, telling True BASIC where to position the output graphics and what size to make them.

Complicated graphics operations such as point plotting, axes, polygon drawing and shading, and textual labels are all built into True BASIC and can be managed by single statements. Programmers can use all the colors available on a given computer with assurance that True BASIC will make reasonable approximations when these programs are ported to other kinds of machines.

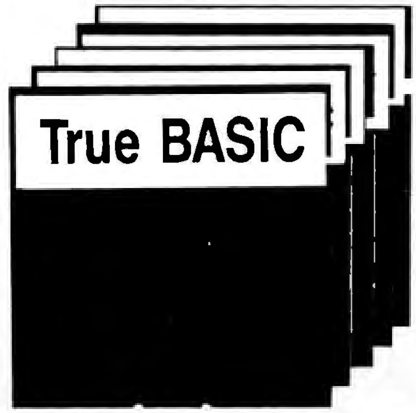
Perhaps most exciting, True BASIC lets you define "pictures" or graphic subroutines. When a picture is drawn, its output can be moved, rotated, shrunk, or expanded—thus a "house" picture could repeatedly call a "window" picture to draw several windows. Each time the picture of the window could be moved to a new location, and perhaps it could be shrunk or expanded.

The True BASIC Environment

True BASIC provides more than just a language system. Also included are an integrated "smart" screen editor and debugger. The screen editor has a knowledge of BASIC syntax so that you can easily mark and manipulate statements, loops, and functions. In many ways, this editor resembles a word processor geared toward the BASIC language.

Along with the standard BASIC system commands such as NEW and OLD, etc., are the PRINT, PLOT, LET, CALL, SET, and ASK commands. These let you inspect and/or change the values of variables, call functions, and draw pictures—all in "immediate mode."

Novice users may wish to type their programs with line numbers, as in older BASICs. But more experienced users will probably prefer the screen editor, especially in its "split-screen" mode, where the program text and the output of the running program may be displayed simultaneously.



Not Just for Education

Kemeny and Kurtz have designed True BASIC primarily for the high school and college educational markets. As Kemeny points out, both publishers and authors have been hurt seriously by the multitude of incompatible BASICs running on different machines. Authors could not hope to have their programs work on more than one or two different microcomputers.

Various publishers have been contacted about True BASIC, and have shown great interest in such a portable language. Authors, too, have been enthusiastic. "Look," says Kemeny, "They are just dying for a way to get their programs out to the students."

But Kurtz mentions that commercial software houses have also shown interest in the product. "Any time a good version comes out, it's useful to programmers." [**Editor's Note:** Very little concrete information was available about True BASIC at the time of this writing. True BASIC Inc. reports that it expects to have the IBM PC version of the language ready for testing and evaluation by hardware vendors by June 1, 1984, with a release to the general public slated for October 1, 1984. All of the claims made for True BASIC in this product description could not be verified. We include this material because True BASIC is backed by two of the most respected individuals in the BASIC language community, John Kemeny and Thomas Kurtz.]

Brig Elliott is vice-president of product development at True BASIC Inc. (39 South Main St., Hanover, NH 03755). He comes to the company after 10 years as a systems programmer and manager.

BetterBASIC

Combining the best of BASIC and Pascal provides a more powerful language that doesn't lose its friendliness

G. Michael Vose
BYTE Senior Technical Editor

BetterBASIC is a product of Summit Software Technology Inc. (40 Grove St., Wellesley, MA 02181). It is a version of BASIC designed to run initially on the IBM PC and PCjr computers and their compatibles. The language will be available for other MS-DOS machines within a year.

BetterBASIC is incrementally compiled, provides separate user-defined procedures and functions, and is extensible through the use of modules. Modules can be created by programmers from within the language. Special-function modules for graphics, windows, and future capabilities will be available from the company in coming months.

BetterBASIC's design emphasizes the benefits of structured programming by offering strict data typing, readability enhancements, and a variety of control structures, particularly procedures and functions. Procedures and functions are scoped so that variables within them are local; they can be made accessible to outside structures with programmer intervention.

The Modular Structure of BetterBASIC

One of the unique features of BetterBASIC is its modularity. BetterBASIC consists of a number of different modules that you can configure to produce a version of BetterBASIC with exactly the capabilities of a particular hardware configuration and/or application. Furthermore, you can create your own new language statements and "package" these new statements into modules that can be made a permanent part of BetterBASIC.

In its most basic form, BetterBASIC consists of two separate modules that must always be present on the program disk:

B.COM — This is the primary executing portion of BetterBASIC, loaded into memory by the command "B." Once loaded, this program begins executing and will load B.DEF, the second portion of BetterBASIC, into memory.

B.DEF — This file contains the actual language definitions for BetterBASIC and will always be loaded immediately after B.COM. Both B.COM and B.DEF must be contained as files on the program disk.

Together, B.COM and B.DEF produce a limited but complete plain-vanilla version of BetterBASIC that executes in the standard MS-DOS operating-system environment. Because BetterBASIC is an extensible language, this form of BetterBASIC can now be used to extend the language through the creation of BetterBASIC modules.

A BetterBASIC module is a separately compiled, relocatable software unit containing BetterBASIC procedures and/or functions, as well as any static data shared by the procedures/functions contained in the module. Once a module has been loaded into memory, those procedures and functions that have been declared public will be available as extensions to the vanilla version of BetterBASIC.

The BetterBASIC Programming System comprises these basic modules plus a number of sophisticated language-extension modules that together result in the BetterBASIC programming environment.

The BetterBASIC Configuration File

The loading/creation of a custom version of BetterBASIC is controlled by an optional configuration file, B.CNF, that contains the names of modules to be used in a programming session, as well as other information controlling the various operating modes of BetterBASIC. If B.CNF does not exist on the program disk, the plain-vanilla version of BetterBASIC results.

If B.CNF exists, it will be a simple ASCII file containing load-time information in the form of one or more lines of text. Each line of text generally specifies either the name of a module to be loaded or a BetterBASIC language parameter to be set (see Specifying BetterBASIC Parameters).

Specifying Modules

To specify that a particular module be included in the loaded version of BetterBASIC, simply add a line, as

follows, to B.CNF:

MODULE=*filename*

More than one module may be specified in a single line, as follows:

MODULE=*filename1*+*filename2* +. . . . +*filenameN*

Specifying BetterBASIC Parameters

B.CNF may also contain directives to set several BetterBASIC parameters to specified values, as follows:

STACK=hexnum — This directive allows you to specify the size of BetterBASIC's internal stack. This stack holds dynamic (recursive) variables. A larger stack allows more local dynamic variables. The default size is currently hexadecimal 2800. If the number given is less than hexadecimal 2800, the default size is used.
PREC=num — Allows you to specify the real math precision. The number must be in the range of 6 to 24 decimal.
AUTODEF=ON/OFF — Sets BetterBASIC's Autodef mode to on or off. The default is on.
INTERRUPT=ON/OFF — Sets BetterBASIC's Interrupt mode to on or off. The default is off.
USERMEM=hexnum — Reserves a given number of paragraphs for user memory, i.e., memory that will not be allocated to BetterBASIC and can be requested by an assembly-language procedure in a user module.
STATUS=ON/OFF — Enables/disables the status-line display at the bottom of the console display.

Available Modules

The full BetterBASIC system includes the following modules:

B.EXT — This module provides a number of useful procedures and functions in addition to the standard built-in procedures and functions provided by B.COM and B.DEF, such as RND, RANDOMIZE, HEX$, and others.
FILEIO.DOS — Provides a flexible interface to the MS-DOS disk-file system. It allows BetterBASIC to interact with both sequential and random record disk files. For sequential disk-file access, the FILEIO procedures offer Microsoft BASIC-compatible syntax, while for record-oriented I/O, BetterBASIC's record variables provide a higher-level syntax.
CONSOLE.IBM# — Provides access to the IBM PC's special-function keys, and implements a screen editor that allows flexible editing of a BetterBASIC program. This module also provides compile-time and run-time support of the IBM PC's function keys (F1–F10).
GRAPHICS.IBM - Supports the IBM PC's color-graphics adapter and provides high-level graphics statements, such as CIRCLE, PAINT, DRAW, etc. Photos 1 and 2 demonstrate the language's graphic output.
WINDOWS.IBM — Allows the IBM PC's display screen (monochrome or color) to be divided into separate, independent display windows. Each window can display data independently in scrolling or nonscrolling modes. Data can be read from and written to any window. While the BetterBASIC windows will generally be nonoverlapping, provision has been made for "pop-up" windows that can temporarily overlay other windows. Photos 3 through 5 show sample BetterBASIC windows.
HELP — Provides on-line help functions using a pop-up window to display help information about a particular topic. Being a module, this allows the help feature to be removed once a user becomes proficient in BetterBASIC.

Industry Standards

BetterBASIC is syntax compatible with Microsoft GW (Gee Whiz) BASIC and IBM PC BASIC. Many of the Microsoft BASIC (MBASIC) keywords are duplicated within the language. In all, BetterBASIC has 140 keywords.

BetterBASIC implements approximately 80 percent of the keywords in the BASIC standard proposed by

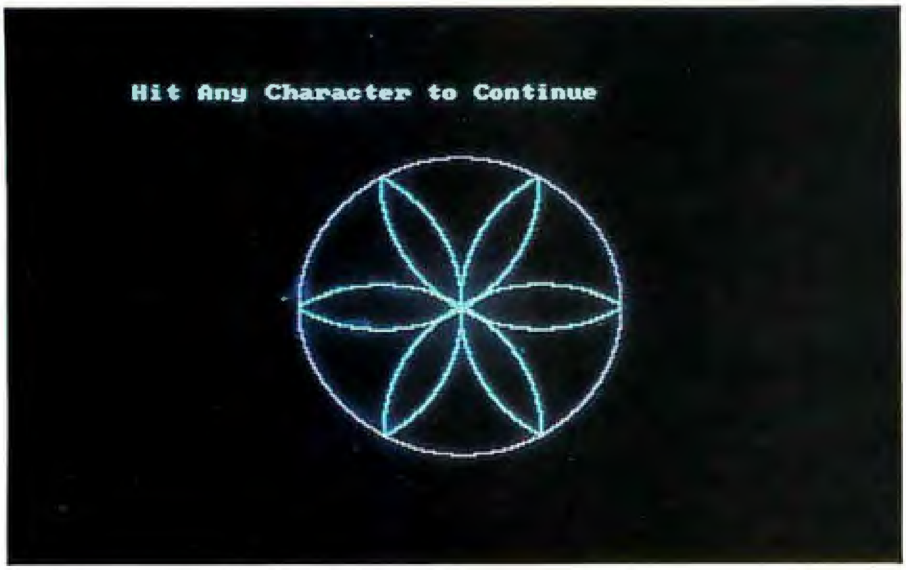


Photo 1: *A sample of BetterBASIC graphic output.*

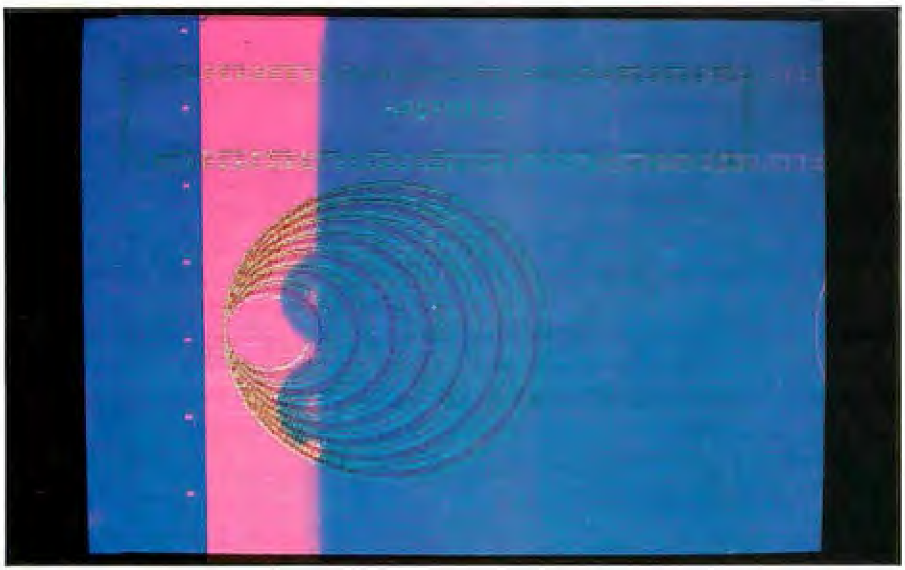


Photo 2: *A BetterBASIC graphic drawn using the CIRCLE command.*

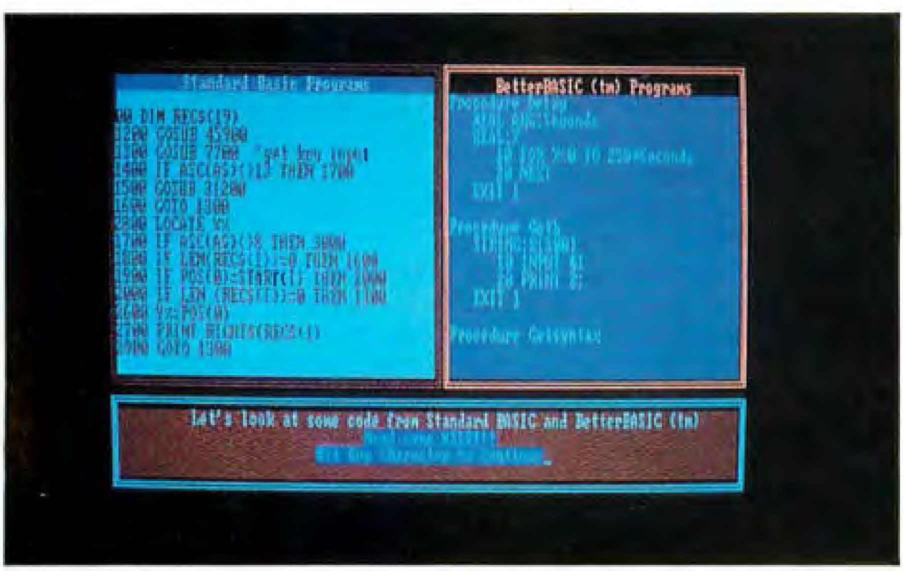


Photo 3: *Windows, with standard BASIC on the left and BetterBASIC source code on the right.*

ANSI (American National Standards Institute). Its math conventions are the same as the proposed standard's, but its graphics keywords, added by a separate module, differ from the standard's, closely emulating the MBASIC graphic keywords.

The language differs from both standards in the following significant ways:

- It encourages strict data typing.
- It provides global and local variables.
- It provides procedures and functions.
- It offers the Pascal-like record-variable data structure.
- It provides the module for adding extensions to the language.

Compiled—Not Interpreted

The ultimate programming language must be easy to learn, easy to use, and easy to transport from computer to computer. These qualities inspired the authors of BetterBASIC to create a language that is compiled to offer speed and efficiency but that retains the interactive nature of interpreted languages like standard BASIC.

Incremental compiling provides both the speed *and* the interaction of BetterBASIC. Each line of source code compiles as it is entered into the computer's memory. As each line is entered, existing program fragments can be run and tested.

This is in contrast to traditional compilation techniques where the entire source-code program is compiled, run, and tested only *after* it is written.

Incremental compilation is fast but its primary advantage may be its error-handling capability. As source-code lines are entered, the compiler finds and reports syntax errors—often pointing out the exact error, like a missing parenthesis—allowing the correction of errors on the spot. Therefore, when a complete program is in memory, it is guaranteed to be syntactically error free.

Standard compilers report errors only during the compilation of the entire source-code program. This makes the correction of syntax and lexical errors time-consuming and tedious, as the source code must be changed and the entire program recompiled.

The code generated by the BetterBASIC compiler is not microprocessor machine code. Instead, the compiler generates pseudo-code (p-code) for the virtual machine, a software construct that interprets p-code for the IBM PC's microprocessor.

This virtual-machine architecture of BetterBASIC makes the language easily transportable among Intel 8086-based, and eventually Motorola MC68000-based, machines.

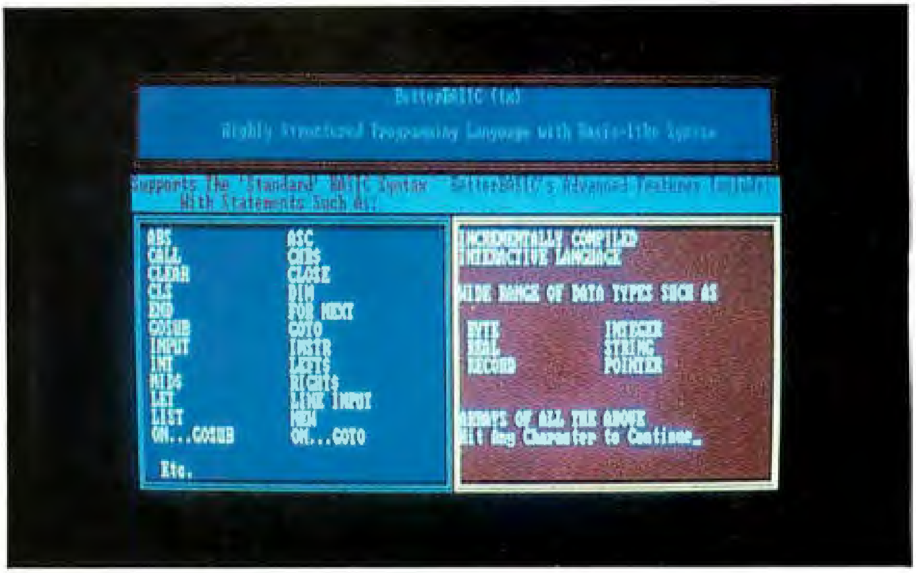


Photo 4: *Another set of windows; note the available data types listed in the right window.*

Photo 5: *A partial list of control structures (right window.)*

Readability

Because one of generic BASIC's strengths is its readable, English-like command structure, BetterBASIC strives to make the language even friendlier with a variety of enhancements.

First, the language permits variable names of unlimited length. Because all characters in a name are significant, names like TEMPERATURE1 and TEMPERATURE2 are possible. Several words can be strung together using the underscore character, as in NET_PROFIT_QUARTER.

These descriptive variable names are a blessing when you decide to make changes to the program. Making a modification in line 400 of your program will be easier if you're looking for the variable NET_PROFIT instead of X or NP.

A second enhancement to program readability is the indentation of code within loops. A BetterBASIC loop looks like this:

```
10 For I = 1 to 10
20   Print I
30   Count = I
40 Next
```

BetterBASIC indents multiple nested-code structures an additional two spaces. For example:

```
10 For I = 1 to 10
20   Print I;
30     For J = 1 to 4
40     Print J
50   Next
60 Next
```

There can be no confusion when reading this code that one FOR... NEXT loop executes *within* the other.

BetterBASIC's most significant contribution to readability, however, is its procedures/functions capability. Discussed in detail later, procedures and functions can replace subroutines, providing a way to write routines with meaningful names that are used in a program just like language keywords.

In addition to long variable names, named procedures and functions, and indentation of code within loops, BetterBASIC provides:

- a way to list all existing procedures and functions with their nesting status and argument types displayed
- a function to display current system status—parameters such as the current precision of floating-point math, and the status of switches such as automatic declaration of variables (see Variable Declaration)
- a function to query the type of variables
- another to determine the number of dimensions in an array

All of these features simplify the maintenance of your program environment and make BetterBASIC programs easier to understand.

Text Manipulators

Text-variable (also called string-

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variable or character-variable) manipulation in BetterBASIC is enhanced by a variety of functions unavailable in previous versions of BASIC. These functions include the traditional INSTR, LEFT$, RIGHT$, and MID$ operators and add new operators to convert between uppercase and lowercase, to insert and delete characters from strings, and to append text to a string.

The text operators in BetterBASIC not only perform standard string-search functions but also double as assignment statements. This permits operations such as

```
200 RIGHT$(Name$,6) = "Client"
```

Strings in BetterBASIC default to 16 characters but can be declared to any length up to 32,767 characters. The practical limit to string length is much lower, of course, but this limit is the only kind that BetterBASIC is subject to.

Variable Declaration

As highlighted earlier, BetterBASIC variables are easy to track because they use descriptive names. Of equal importance is the capability to type all variables—to specify a variable as an integer, string, or other type (see the A Closer Look at Data Types section that comes next).

Strict data typing gives you the flexibility to use the kind of variable types that will guarantee that your programs are as fast, and use as little memory, as possible. This facility also aids program maintenance. BetterBASIC lists all variables by type at the beginning of the source-code listing of all program structures.

There are two kinds of variable declaration in BetterBASIC: explicit declaration, a "structured-programming" technique useful primarily to aid maintenance and debugging; and first-use declaration, sometimes called automatic declaration.

Standard BASICs use both techniques, but BetterBASIC has a switch that lets you turn off the automatic declaration of variables, forcing you to use explicit declarations. In this way, BetterBASIC can help you acquire better programming technique.

A Closer Look at Data Types

BetterBASIC offers seven data types—integer plus a subset, byte, real-number, string or character, record, a pseudo-data type called a pointer, and arrays of all the other types.

A byte data type and an integer data type are both whole numbers. Bytes are in the range 0 to 255, while the range for integers is −32,767 to +32,767. Bytes require a single byte for storage in memory while integers consume up to 2 bytes.

Real numbers in BetterBASIC have a range of 9.99×10^{-255} to 9.99×10^{253}. Real numbers require up to 16 bytes for storage in memory, depending on the chosen precision for floating-point math operations.

String data types store the ASCII (American National Standard Code for Information Interchange) representation of the intended data and require 1 byte of storage for each character plus 2 bytes for overhead.

A record data type is a complex variable comprised of fields that can be any of the other BetterBASIC data types (see Record Variables).

A pointer is a pseudo-data type used to "point" to another data structure. Changing the value of a pointer changes the value of the variable it points to. Pointers are useful in linking record variable fields.

Arrays of all data types constitute another data type. BetterBASIC even supports arrays of arrays.

Arrays and record variables are structures that are built using the BetterBASIC command (*type* ARRAY) (RECORD) STRUC. This command lets you build and name shapes, or templates, of complex data structures without consuming any memory. You can then declare a structure of a given shape when you need it for data manipulation.

There are declaration statements for each data type in BetterBASIC. For example, the declaration

```
INTEGER Counter, Flag, Number
STRING Password
REAL Net_Profit, Gross_Profit
```

creates three integer variables named Counter, Flag, and Number; a text variable called Password; and two real variables called Net_Profit and Gross_Profit.

These variables will always appear in a table at the top of any listing made of the source code of the program structure in which these variables appear.

BetterBASIC variables are local to the program structure in which they are created. You can declare an integer variable called Counter in your main program, and it will be unknown inside any procedures or functions you write. In fact, you can subsequently declare a variable called Counter within a procedure, and that variable will be different from the main program variable Counter and unknown to the main program. In this way, BetterBASIC provides unparalleled data integrity.

Record Variables

Of all its data types, BetterBASIC's record variable is the most flexible. Similar to Pascal's record variable, this data type is an amalgam of separate fields, each of which can be any other data type—even arrays or other record variables. A record variable is thus similar to an array except that the elements can be of any type or size. The elements of a record are addressed using the notation

recordname.fieldname

For example, to extract the entry in a record variable named Payfile1 for the information for a Name field storing the value Jones, you would write

```
PRINT PAYFILE1.NAME
```

and would receive the following display:

```
JONES
```

The record, Payfile2, would contain another name (presumably with a variety of facts associated with the name).

Pointers

Pointers are pseudo-variables in BetterBASIC. Their primary purpose is to permit the linking of record vari-

able fields. To establish a pointer, it must be SET—that is, it must be assigned to a variable to point to that variable.

An example will clarify this process. Assume the existence of a record variable, Payfile1, with a field, Name, containing the data, Jones. The assignment operation

```
SET P = PAYFILE1.NAME
```

will establish P as a pointer, pointing at the variable, Payfile1.Name. A subsequent

```
PRINT P
```

yields

```
Jones
```

Similarly, the following steps alter the contents of Payfile1.Name:

```
P ="Smith"
PRINT PAYFILE1.NAME

Smith
```

As you can see, changing the pointer also changes the data stored in the variable pointed to.

Typically, pointers are used within record variables to link one record to another. This is done by simply declaring a field of the record to be a pointer.

The ability to write stand-alone procedures and functions that allow modular programming is one of BetterBASIC's principal features.

Here is how a BetterBASIC record variable is declared:

```
Record STRUCT:PAYROLL
(STRING:Name,Street,City,State
REAL:Zip,Gross Pay,Deduct
PTR:Link)
```

This syntax builds a template for the creation of record variables with eight fields. To declare actual variables, you now enter

```
PAYROLL: PAYFILE1,PAYFILE2,
  PAYFILE3
```

to create three variables with the structure, Payroll, having the names Payfile1, Payfile2, and Payfile3. We can link these three record variables together by setting their pointers. This operation is shown below:

```
SET PAYFILE1.LINK = PAYFILE2
SET PAYFILE2.LINK = PAYFILE3
SET PAYFILE3.LINK = PAYFILE1
```

Stand-alone Constructs

The ability to write stand-alone procedures and functions is one of BetterBASIC's principal features. These constructs allow truly modular programming. They can be virtually unlimited in length, are unknown at all levels except the one in which they were created, and can have their own local variables, arguments, DATA lists, and local error-handling routines.

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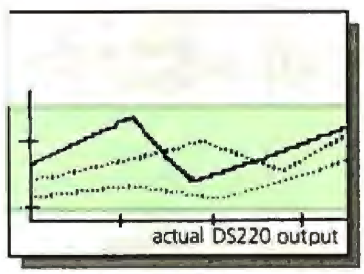

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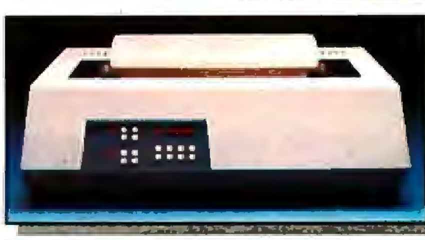

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Listing 1: *The function, Age, followed by a program to call it with the argument, Birthyear, and print the result. Note that Birthyear is a separate variable in the main program and the function.*

```
.INTEGER FUNCTION Age
Integer Function: Age
234567 Bytes Left
:10 INTEGER ARG Birthyear
:20 RESULT = 1984 - Birthyear
:main
INTEGER Birthyear
.10 INPUT "Enter the year of your birth: ";Birthyear
.20 PRINT "You are ";Age(Birthyear);" years old."
```

Stand-alone procedures and functions are made possible by a division of the computer's memory resources into segmented work spaces. Initially, there is only a single BetterBASIC work space, the main program work space denoted by the prompt ".". But each time a procedure or function is declared, a new work space is created. A procedure/function work space is denoted by the prompt ":". The on-screen status line also indicates the current work space, in addition to other items such as real-number precision, auto-declaration on or off, and whether interrupts are on or off.

Procedures and functions are scoped so that they can be called at the level of their creation. If a procedure is declared at the main program level, it can be called from that level only. It cannot be called by another procedure or function (unless it is made external, see below). Similarly, a procedure created from within a procedure can be called by that procedure only—it cannot be called from the main program or from any other procedure outside the one that created it.

Procedures

Procedures are declared by entering the keyword, PROCEDURE, followed by a name. The name can be a simple word or a complex label containing several words linked by an underline character (_), as in SWAP_NUMBER_ROUTINE. On entry of the statement and name, the screen displays

```
.PROCEDURE CLS
Procedure:CLS
256712 Bytes Left
:
```

To write the code for the procedure, the programmer proceeds as in the main work space, using line numbers and any and all BetterBASIC keywords. Because line numbers and variables are local to the procedure, you can use the same line numbers and variable names used elsewhere without conflict (although possibly not without confusion with variable names). For example, to complete a clear-the-screen procedure, you could enter

```
:10 PRINT CHR$(12)
```

REM ASCII character 12 is the IBM PC clear-screen character

```
:20 PRINT "Ok"
```

REM just a fancy prompt

```
:main
```

The keyword MAIN prompts an exit from the procedure work space back to the main work space. At this point, the procedure is called by entering its name:

```
. CLS
```

or by using the name in a program line:

```
.100 CLS
```

This invokes the procedure and clears the screen, printing an "Ok" at the top.

The scope of procedures and functions can be altered with the keyword EXTERNAL. The scope of variables can also be changed using this keyword. EXTERNAL can make a variable or an entire procedure or function visible to other program levels.

Functions

Functions are created and called in the same way as procedures. In this way, they are substantially different from the functions in standard BASIC. They can be as long and complex as you care to make them. Functions are subject to the same scope rules as procedures.

Functions require at least one argument (it may be a dummy argument) and return a result. Listing 1 is an example function to compute a person's age—it requires the year of birth as an argument.

A RESULT statement forces an exit from the function with the returned value as the result. A function may have multiple RESULT statements but will exit on initial execution of one.

Arguments

Functions require at least one argument but either functions or procedures can receive arguments of any data type, including arrays and records. In the latter case, a special argument class, the ANY ARG, is used to permit the passage of an unknown data type (required because record variables can contain mixed data types). ANY argument declarations can be used at any time in a procedure or function, but specific data-type declarations are preferable and constitute good programming practice.

Error Handling

Procedures and functions can include error-handling routines to handle the typical errors to which the construct might be vulnerable. If no error routine is included, the scoping rules of the language call the error-handling routines at the program level that called the procedure or function. If no routines exist at this level, all the way back to the main program level, BetterBASIC then issues a system error message and halts execution as in standard BASIC.

Extending the Language

BetterBASIC's most significant feature is its use of modules. A module can be created by any BetterBASIC programmer and linked to the existing language system at configuration (see The BetterBASIC Configuration File on page 302). A module is usually desirable as a permanent addition to the language. They are not limited to code written in BetterBASIC. Modules can also contain assembly-language code. In this way, it becomes simple to adapt the language to specific hardware or even to make application programs part of the language.

It is the module that makes the language extensible. For example, to make the earlier example procedure CLS part of BetterBASIC, it can be made into a module with the command

```
.MAKE MODULE
```

Execution of this command eliminates the procedure's source code and retains the virtual-machine object code. The module is assigned a module number that is displayed on the screen. At this point, CLS becomes a new keyword in the language, callable at any level.

Conclusion

BetterBASIC is a substantial improvement to previous versions of the language, but a major concern is whether there is a need for yet another version of BASIC. All BASIC designers hope their version will become standard, and a standard language would seem to allow no room for competitors. It could be that the public perception of Microsoft BASIC as a standard may make it impossible for other versions of BASIC, regardless of worth, to gain a toehold in the marketplace.

The problem, then, for purveyors of upgraded language products becomes one of educating the potential market about the advantages of their products. A modicum of luck may be required, as well. The history of successful microcomputer software to date has shown that the surest way to the top is often on the coattails of a significant new piece of hardware. ■

G. Michael Vose is features editor of BYTE (POB 372, Hancock, NH 03449).

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Macintosh BASIC

A semicompiled language with tools designed to simplify the writing of code

Scot Kamins
Technology Translated Inc.

Since so many things about Apple's new Macintosh computer are different from other computers, it should come as no surprise that Donn Denman's Macintosh BASIC is also different. Briefly stated, Macintosh BASIC is a semicompiled, multitasking, structured language system (without line numbers), complete with a full-screen text editor and a highly sophisticated debugger, that takes advantage of many of the Macintosh's unique features. This article describes what is unique about the language.

Macintosh BASIC is semicompiled. When you type in a new program line, the line is immediately passed to a part of the system called the *B-code generator*. This generator compiles the program line and updates the program data structures. The system checks the syntax of the line as the line is compiled and provides immediate feedback as to the line's general lexical correctness. Later, when the program is executed, the compiler makes another quick pass through the program (about 2 seconds for a 50K-byte program) to check the integrity of its control structures. Assuming there are no final compilation errors, program execution continues. The compact B-code is then interpreted, making for a very fast BASIC.

Macintosh BASIC is quite large (48K bytes), and it can grow. It is segmented; about 32K bytes live in memory at any time, leaving about 50K bytes for program and variable table space. (Actually, because of the CALL command, programs can be virtually any length.) If a program needs a part of BASIC that isn't in RAM (random-access read/write memory), such as formatted output, the editor, the debugger, or some other large code segment, it loads in from the disk.

Macintosh BASIC lets you execute any number of programs simultaneously and develop one or more additional programs at the same time (see figure 1). Each time a line of code is interpreted, the system checks for other events that might need attention and handles them accordingly. Each program is granted a fixed amount of execution time in 1/60-second increments or any interval set by the programmer. When a program's time slice is up, the system moves to the next program for interpretation.

No line numbers are required in Macintosh BASIC. You get around the program by branching to sections of code identified by *labels*. You can use numbers, but labels tend to be a lot more meaningful and make tracing program flow much easier.

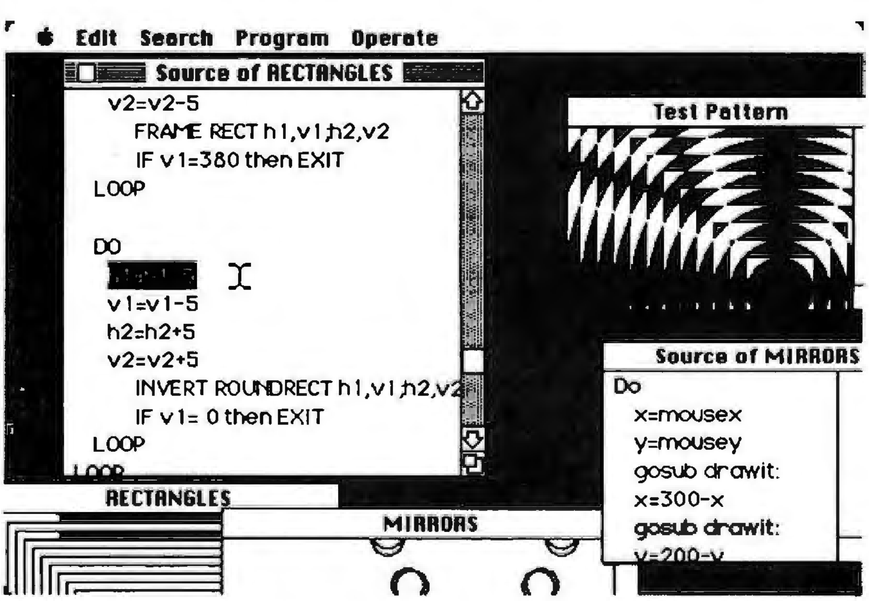


Figure 1: *Multitasking in Macintosh BASIC.*

Environment

In most BASICs, the entire display area is ordinarily occupied by the program listing or by the output. In Macintosh BASIC, the display area, called the *desktop*, is typically oc-

cupied by a variety of graphics and text material. Most material appears in *windows*, sections of the desktop that can grow, shrink, or move at the discretion of the programmer. Figure 2a shows the BASIC desktop with three copies of the same program in windows of different sizes. Listing 1 shows what the whole program looks like; you can't see all of it because all of it won't fit in the viewing area of the Listing window. Figure 2b shows what running the program produces. Note that none of these windows shows an entire program; there are more lines in the program than will fit in any of the visible areas. To see the rest of the program listing, you press the mouse button with the pointer on the down arrow in the *scroll bar* (located at the right of the window), revealing the rest of the code.

When a Macintosh BASIC program is executed, the Listing window is overlaid by an Output window that displays any text or graphics produced by the executing program. Both the Listing window and the Output window can be (and often are) displayed at the same time, making program development and debugging easier than in traditional environments.

Macintosh BASIC's tools and command words (verbs that affect programs as a whole, like RUN, LOAD, and SAVE) appear in menus whose titles are listed in the *menu bar* running across the top of the desktop. To choose a menu item, use the mouse to move the pointer to the menu you want, press and hold the mouse button, and drag the pointer down to the specific tool or command you want.

The Macintosh BASIC interactive programming environment makes writing code a lot easier than do most other BASICs because of the huge variety of tools. The tools include those available to every Macintosh application (specifically, the *desk accessories*, the screen-oriented editor, and the Clipboard) and a set of special development and debugging aids designed for the language, including flexible search and replace capabilities, several printing options, and a very sophisticated debugger.

Desk Accessories

Among the desk accessories, accessible from the desktop menu, programmers will find the Calculator, the Note Pad, and the Clock most useful (see figure 3). The Calculator is a simple four-function calculator useful for doing quick operations; you can use the system editor to transfer calculation results into your program code. The Note Pad lets you write memos to yourself about special sections of code that need attention, or anything else you need to remember but don't want to scribble on a piece of paper that will quickly get lost. The Clock is extremely useful, either to time program execution or to remind a hacker when to eat lunch. You can have all these tools (and any others, for that matter) operating while you develop and run programs.

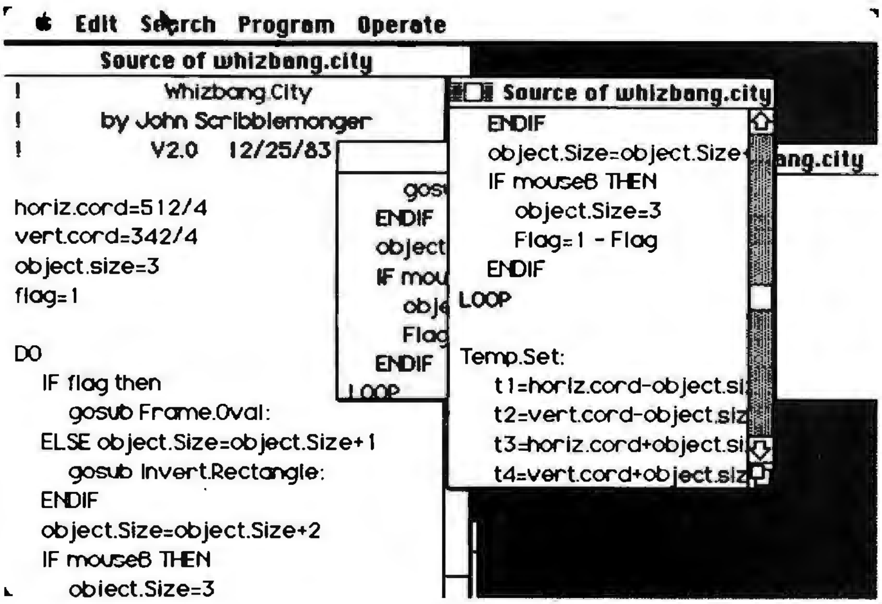
Using the mouse and the screen-oriented editor, you can cut, copy, paste, or entirely remove all or part of a program. In combination with the Clipboard, the system-wide text and graphics buffer, you can quickly and easily move whole blocks of code from one section of a program to another section of the same program or to a different program (see figure 4). Additionally, you can move material into (or out of) the BASIC programming environment from any other Macintosh application including a spreadsheet, a word processor, or the Mac Paint graphics application.

Also on the Menu

The other menus provide access to tools specific to Macintosh BASIC. Among the tools seldom seen in other systems are Search and Replace, in the Search menu; Debug, in the Program menu; and Directory, in the Operate menu.

The search tools help you to locate and/or change any group of characters, either once or repeatedly, matching or ignoring the case of the alpha-

(2a)



(2b)

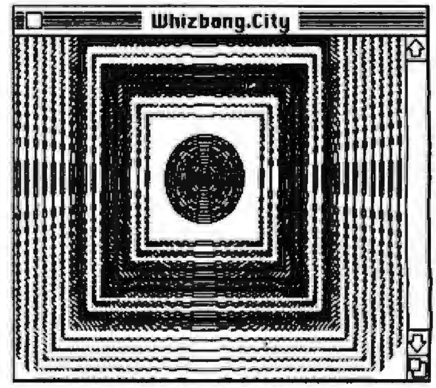


Figure 2: *Three "views" of the same program in windows of different sizes (2a). None of these windows shows an entire listing (see listing 1 below). Figure 2b shows the Output window for the program Whizbang.city (listing 1).*

betic characters. These search tools can be extremely useful for changing a nondescriptive variable to one that makes more sense—say, changing all occurrences of the variable E7 to EMPLOYEE.7—or to replace improper spellings in variable names, labels, or prompting phrases.

Listing 1: *The Whizbang.city program.*

```
!                     Whizbang.City
!            by John Scribblemonger
!                    V2.0      12/25/83

horiz.cord=512/4
vert.cord=342/4
object.size=3
flag=1

DO
    IF flag then
        gosub Frame.Oval:
    ELSE object.Size=object.Size+1
        gosub Invert.Rectangle:
    ENDIF
    object.Size=object.Size+2
    IF mouseB THEN
        object.Size=3
        Flag=1 - Flag
    ENDIF
LOOP

Temp.Set:
     t1=horiz.cord-object.size
     t2=vert.cord-object.size
     t3=horiz.cord+object.size
     t4=vert.cord+object.size
Return

Frame.Oval:
     Gosub Temp.Set:
     Frame Oval t1,t2; t3,t4
Return

Invert.Rectangle:
     Gosub Temp.Set:
     Invert Rect t1,t2; t3,t4
Return
```

The Program menu (see figure 5) lists the command verbs, or menu selections, programmers tend to use most during code development, including certain commands not available or meaningful in other BASIC systems. Most notable here are the two Save commands, the Update command, and the Debug command.

Selecting Save Source sends an ASCII (American National Standard Code for Information Interchange) text copy of the program to the disk, just as it appears in the Listing window. Save Object stores only the program's B-code—that is, the code in its compiled form. You can retrieve, edit, and execute a program saved as text, but a program saved as code can be

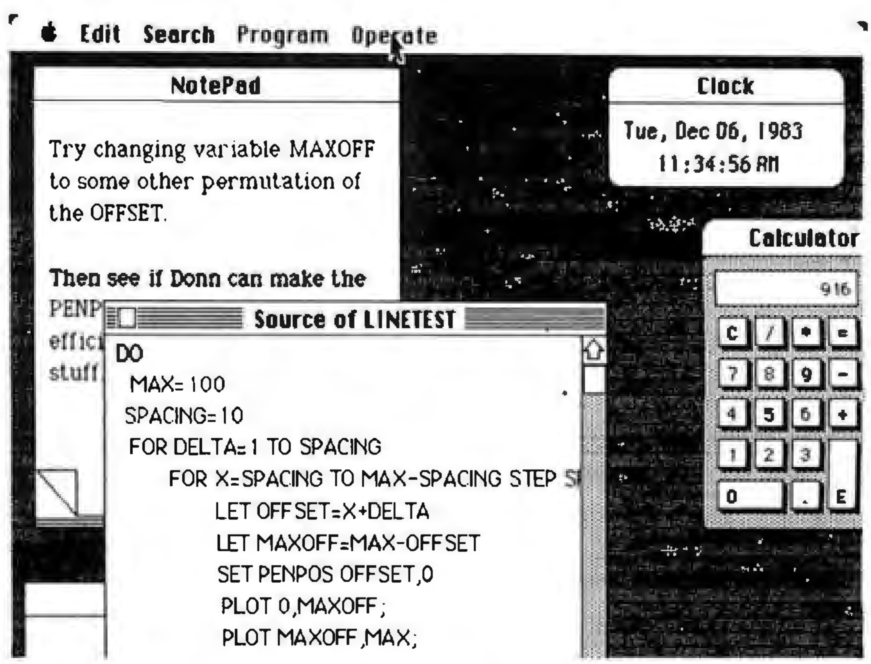


Figure 3: *Macintosh desk accessories run concurrently with program development. The Note Pad (in the background) has eight pages and holds 256 bytes per page.*

executed only. Code files are safe from tampering; once they go to disk, they cannot be viewed or changed. Thus, profit-minded programmers can protect their code from the prying eyes of unscrupulous code pilferers. Update lets you modify running programs. You can change a program line in the Listing window, select Update from the Program menu, and watch the immediate effects of the change in the Output window.

Choosing Debug turns on the debugging environment. When this command is in effect, the normal Listing window is replaced by the one in figure 6. The finger symbol moves up and down the listing, pointing to the line of code currently being executed. Simultaneously, the system displays a dynamic variable and breakpoint table showing the current values of all non-array variables; all of these values can be changed while the code being debugged is executing (updating is automatic).

You can set and clear breakpoints for any or all variables. The program can break whenever a particular variable is referenced or changed or is equal to, less than, or greater than some value or other variable. When the program hits a breakpoint, execution halts and it waits for the programmer to determine what happens next. By using the mouse to press a button displayed on the desktop beneath the Listing window, you can make execution resume at full speed until the next breakpoint, full speed through the next control block (a DO/LOOP, FOR/NEXT, SELECT CASE, subroutine, etc.), or go immediately into a single-step mode. In single-step mode, only one line of code is executed; the programmer tells BASIC to execute each subsequent line of code by pressing the space bar.

Additionally, there's an alphabetical list of all the labels in the program. This feature makes it easy for you to see why you got that "undefined label" error when your program is trying to branch to CALL.YOUR. MOTHER: instead of to CALL. YOUR.MOM:.

Function	Description
BTN	tells which interactive button has been pushed
DIAL	tells which interactive dial has been activated
FORMAT$	Macintosh BASIC equivalent of PRINT USING
KBD	gives the ASCII code of the most recent key pressed
MENU	tells when an interactive menu is chosen
MOUSEB	yields the state of the mouse button
MOUSEX	returns the horizontal position of the mouse pointer
MOUSEY	returns the vertical position of the mouse pointer
TYP	tells the data type of the next item in the input stream (numeric, string, or picture)

Table 1: *Macintosh BASIC numeric data types.*

Storage Form	Symbol	Accuracy	Range
Double-precision real	none	15	1E +− 1022
Single-precision real	|	7	1E +− 126
Extended-precision real	\	18 +	1E +− 4000
Short integer	%	4 +	+− 32767
Long integer	#	18 +	+− 9E18
Boolean	-	1	0 or 1

Table 2: *Some Macintosh BASIC functions not available in most other BASICs. "Interactive" refers to graphics objects (menus, buttons, dials) that appear on the screen and can be manipulated with the mouse.*

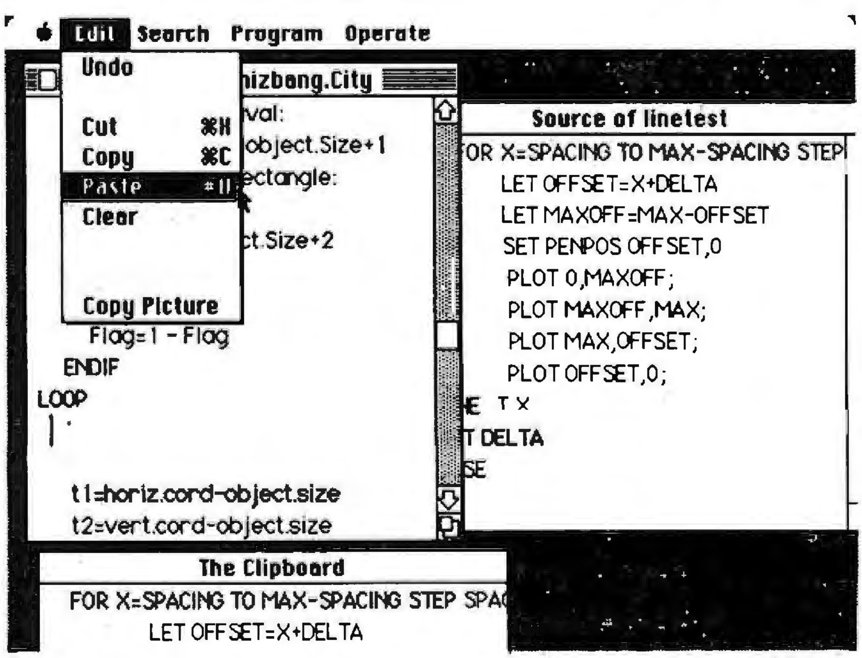


Figure 4: *Material in the Clipboard, just copied from the Linetest program on the right, is about to be pasted into a second program. The source lines in Linetest remain undisturbed.*

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The Operate menu holds commands you might typically use to test programs. RUN is the usual BASIC command to execute a program (something in this language has to be usual). In Macintosh BASIC, Halt and Continue are useful for checking the program's Output window and variable table from time to time. The Directory selection produces a menu of all BASIC programs on the disk; drag the pointer to one of the program names and BASIC loads the program for you. The Quit command is your way out of BASIC, returning you to the main Macintosh system (called the Finder).

With Macintosh BASIC, you can obtain four kinds of hard-copy printouts: everything on the screen, everything in the Listing window including material you can't see, all text and graphics in the Output window, and material sent to the printer by the running program itself. The listings in this article were all printed directly from the Macintosh.

The Language

Variable names in Macintosh BASIC can be of any length, and all characters in the name are significant. The first character must be alphabetic; the rest can be nearly anything you can type from the keyboard, which includes the entire ASCII code set plus nonroman and other special characters. The only exceptions are arithmetic symbols and other delimiters (comma, semicolon, colon, and space).

Macintosh BASIC supports array variables for all eight data types and subtypes discussed later. Arrays can have any number of dimensions, and each dimension can have 32,767 elements. All arrays must be dimensioned before use. When you DIM an array, you can specify ranges for element numbers. Thus, you can say DIM YEAR%(1900 TO 1986) to specify an 87-element integer (the % denotes integer) array whose first number is 1900 and whose last number is 1986. You can also stipulate ranges for separate dimensions, as in DIM NAME$(10 TO 75, 165 TO 300).

There are three main data types in the language: strings, pictures, and numerics. Strings are pretty standard; they are enclosed in quotes, either single or double, and their variable names end in the usual BASIC symbol, $.

You create a picture data type by either creating a shape or a whole picture in a graphics application (like Mac Paint) and transferring it to BASIC through the Clipboard or by drawing a shape in BASIC using various graphics commands. You can then assign the shape to a picture variable; the variable name ends in the symbol @.

The numeric data type is further divided into six subtypes: Booleans, two types of integers, and three types of reals. Table 1 shows the storage form, symbol, range, and digits of accuracy for each subtype.

In addition to the five standard arithmetic operators (+, −, *, /, ^), Macintosh BASIC includes DIV for integer division and MOD for modulo, defined as the arithmetic remainder of integer division. The relational operators (<, =, >, <>, ><) and logical operators (AND, OR, and NOT) are standard; the string concatenation symbol is &.

Macintosh BASIC has the usual range of arithmetic, trigonometric, and string functions, including DEF FN (user-defined functions) for both numbers and strings. Table 2 describes many of the functions that don't appear in most other BASICs or are unique to Macintosh BASIC in some major way. The term "interactive," appearing in several of the descriptions, refers to graphics objects (entire menus, buttons, dials) you can make appear on the screen and can manipulate with the mouse.

Control Structures

Most flow of control statements in Macintosh BASIC take the form of control structures. The language has a GOTO statement, but you never have to use it. In fact, the only place the GOTO statement appears in the language manual as part of a code example is in the section describing GOTO itself.

Besides the familiar FOR/NEXT structure and the DO/EXIT/LOOP structure, in which all statements between the keywords DO and LOOP are repeated infinitely (EXIT lets you escape the loop), this BASIC includes some variations on new structures proposed in the 1982 ANSI (American National Standards Institute) BASIC proposal. A multiline IF/THEN/ELSE/ENDIF lets you execute

Listing 2: *A multiple-line IF control block.*

```
IF DAY.TEMP > HOT THEN
   CLOTHES$ = SWIM.STUFF$
   GOSUB BEACH:
ELSE CLOTHES$ = WALK.STUFF$
   GOSUB CITY:
ENDIF
```

as many statements as you want if a condition is either true or false (see listing 2). An extremely flexible SELECT CASE/ENDCASE construct takes the place of the restrictive ON...GOSUB statement. It enables the program to transfer execution to sets of statements based on the value of some expression. There can be multiple statements for each case or range of cases (see listing 3). The language has several interrupt control structures, all of which are based on a structure bounded by the keywords WHEN and ENDWHEN; these interrupts let you determine which code is executed if any one of a number of events occurs anytime during program execution. You can plan interrupts to occur whenever a key is pressed, when the mouse is moved or its button pushed, when an error occurs, or at other times (see listing 4).

Subroutines are handled in the usual way (except that the language uses GOSUB labels); additionally there's a CALL statement that enables entire programs to act as subroutines. CALL lets you pass parameters back and forth with the summoned program; when the called program ends, control returns to the statement following CALL in the source program.

Graphics

Macintosh BASIC provides commands for both static and animated graphics on a bit-mapped 512- by 342-point screen. You can plot points with the PLOT command (controlling the size of the pixels with PENSIZE) or create shapes with the keywords RECT (for rectangle), ROUNDRECT (a rectangle with rounded corners), or OVAL. Shapes can be outlined

Listing 3: *A SELECT CASE construct using strings (3a) and a SELECT CASE construct using numerics (3b).*

(3a)

```
Source of SELECT CASE/ENDCASE (STRINGS)
SELECT CASE PARTY$
   CASE "REPUBLICAN"
        CALL REPUBLICAN.PRIMARY BALLOT
   CASE "COMMUNIST"
        CALL MILITIA
   CASE "DEMOCRAT", "TORY", INDEPENDENT$
         GOSUB FURTHER.CHOICE:
         CALL GENERAL.PARTY.BALLOT
   CASE LEFT$(PARTY$, 3) = "SEP"
         CALL SEPARITIST.PRIMARY.BALLOT
   CASE ELSE
        CALL GENERAL.PRIMARY.BALLOT
ENDSELECT
```

(3b)

```
Source of SELECT CASE/ENDCASE (NUMBERS & RANGE
SELECT CASE AGE
   CASE 2, 4, 5
       GOSUB PRESCHOOL:
   CASE 6 TO 12
       GOSUB GRAMMAR.SCHOOL:
   CASE 15, 18 TO 35, VAL (OLD$)
       CALL CHECK.DEMOGRAPHICS
   CASE >70
       GOSUB MIGHT.BE.RETIRED:
ENDSELECT
```

(FRAME), filled in (PAINT) with a preestablished shade or pattern (SET PATTERN), complemented from the last appearance (INVERT), or erased altogether (ERASE). The various shapes can then be combined into a single picture and stored in a picture variable (RECORD PICTURE) and recalled (DRAW PICTURE). For animated sequences, you can ROTATE, SCALE, and ANIMATE a picture, moving it across the display. All graphics appear within the Output window, so your Listing and Debugging windows can coexist with a running graphics program.

Disk File Structures

Disk file structures have many options. I will cover only the major highlights; many of the available statements and options are not examined here.

There are three types of file organization: sequential (serial access for text data), stream (serial access for binary data), and relative (random access, usually for text data). Length of a record in a relative file must be set in advance, but it can be any length

Listing 4: *The interrupt construct for errors and keypress.*

```
Source of WHEN / ENDWHEN
WHEN ERR
   CALL ERROR.CHECK
   GOSUB SECOND.CHANCE:
ENDWHEN

WHEN KBD
   PRINT "WHICH MENU DO YOU NEED?"
   GOSUB MENU.CHOICE:
   CALL MENU$
ENDWHEN
```

you choose; there is no limit (beyond memory) to the number of records in a file.

The keyword RECTYPE determines how data is stored: display files are standard ASCII and can be shown in a window or be printed; internal files are binary and are for storage only. You can designate any file, no matter what type, to be an input file (a file which can only be read), an output file (to which data is sent but not retrieved), or OUTIN (accessible for both input and output). You can later change a file's access designation.

You create a file, and later make it accessible for use, with the OPEN statement. OPEN sets the channel number (1 through 99) that links the file to the system and the name of the file associated with the channel:

```
OPEN #3: NAME "Macmumble"
```

The preceding statement opens a file named Macmumble and assigns it to channel #3. Since no further parameters are given, the file uses the default parameters, which makes it a sequential display file enabling OUTIN access. The following statement opens a relative file with a record length of 250 characters for the storage of ASCII text data.

```
OPEN #54: NAME "Foobar", AC-
  CESS OUTPUT, ORGANIZA-
  TION RELATIVE, RECSIZE 250
```

The OPEN statement is intelligent: after you've opened a file, you don't have to restate the organization, record size, or RECTYPE each time you use it. Assuming you've issued the CLOSE statement for the file "Foobar" described above, you can later access it again by just saying OPEN #54: NAME "Foobar". Up to 10 channels can be open at the same time.

All devices (like the serial port, the printer, windows on the desktop) can be accessed in the same manner as files. Device names are specified in the same way as any filename except that the first character in the name is a period.

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Listing 5: *Five programs used for benchmark tests (5a). Listing 5b is the Sieve benchtest program using Print Quick from the Program menu.* .

(5a)

Source of gosubs

```
print time$;' at start'
for x=1 to 5000
   gosub foo:
next x
print time$;' when done'
end

foo: return
```

Source of loops

```
!Loops
Print "Start at ";time$
FOR I=1 TO 5000
NEXT I
PRINT "Done at ";time$
```

Source of divs

```
print time$;' at start'
for x=1 to 5000
  y=x div 3
next x
print time$;' when done'
```

Source of divides

```
print time$;' at start'
for x=1 to 5000
  y=x/3
next x
print time$;' when done'
```

Source of mid$

```
print time$;' at start'
b$='Apple Computer Inc'
for x=1 to 5000
   a$=mid$(b$,6,7)
next x
print time$;' when done'
print a$
end
```

(5b)

```
! Sieve
s%=8190
dim flags%(s%+1)
print "start ";time$
count%=0
for i%=0 to s%
    flags%(i%)=1
next i%
for i%=0 to s%
    if flags%(i%)=0 then goto 250
    prime%=i%+i%+3
    k%=i%+prime%
200    if k%>s% then goto 240
    flags%(k%)=0
    k%=k%+prime%
    goto 200
240 count%=count%+1
250 next i%
   print 'done ';time$
   print count% ;' primes'
```

Test	Time (seconds)
Empty GOSUBs	3.0
Empty FOR/NEXT loop	1.5
Midstring search	9.0
Real divide (by 3)	18.0
Integer divide (by 3)	3.0
Eratosthenes Sieve (1899 primes)	31.5

Table 3: *Benchmark results.*

```
OPEN #1: NAME ".PRINTER"
OPEN #35: NAME ".SERIAL",
  ACCESS INPUT
OPEN #17: NAME ".WINDOW:
  FOOBAR"
```

The first of the three lines above assigns channel 1 to the printer. Because printers by their nature are write-only devices, you don't need to specify the file as access output. The second line provides the serial port channel #35; its access mode is specified because serial ports are two-way. The third line addresses the Output window created by the program FOOBAR. This enables some other file either to add to the Output window or to read the window's contents.

To send and retrieve data, use the keywords PRINT and INPUT for ASCII text (display files) and WRITE and READ for binary data (internal files). Potential overwriting or "out of data" problems are handled with the

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key phrases IF THERE and IF MISSING.

PRINT #7, RECORD 53, IF THERE THEN GOSUB DONT.WRITE.OVER:: A$

The preceding statement sends a field of text data (A$) to record 53 of the relative file on channel #7. If that record already exists, then program control branches to the subroutine called DONT.WRITE.OVER:. The first colon after the subroutine name is required by label syntax, the second by file syntax.

The following example retrieves two fields of binary data from an internal file hooked to channel 67 and stores them in real variable NUMBER and string variable NAME$; if there's no data there, control branches to a program named PROTECTIT.

READ #67, IF MISSING THEN CALL PROTECTIT: NUMBER, NAME$

The Macintosh provides some fairly sophisticated sound stuff, and BASIC takes advantage of it. You can control the volume, pitch, timbre, and amplitude of each of four individual tones. You can also play any note over a four-octave range. (You can play over a greater range, but really low notes sound too soft and really high ones sound too shrill for my ears.)

Set-options are system parameters that you can control. You can ASK or SET the current value of any set-option. There are set-options for nearly all parts of the language, but the most important ones have to do with graphics, windows, and text. Graphics options include the height and width of the penstroke and the pattern the penstroke produces. Window options control how much of a program's output is displayed on the desktop in pixels, how large the entire graphics area is, and what logical boundaries to associate with physical ones. Text set-options include the current position of the insertion point (the mouse's footprint), margins within which text is to appear, and the number of characters between tab stops.

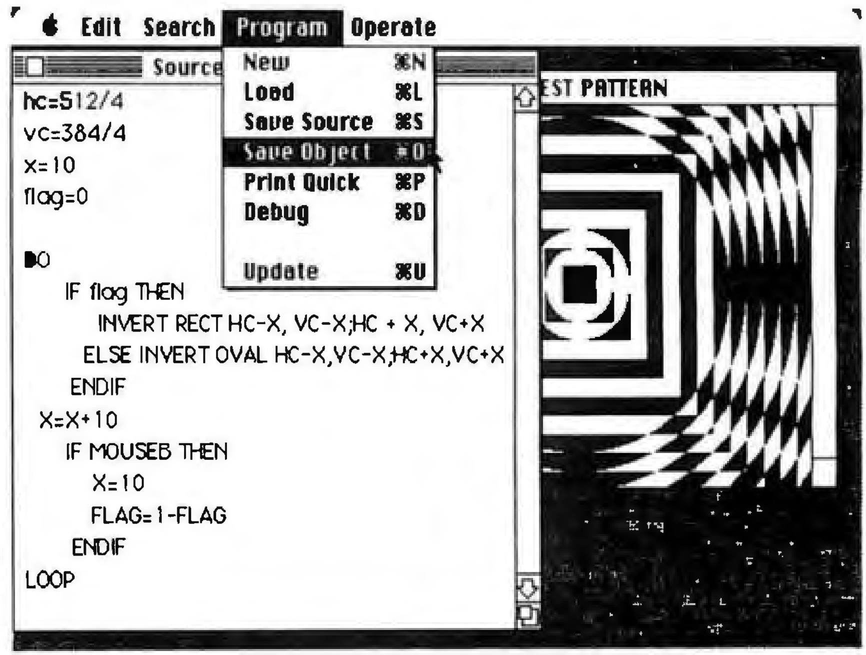

Figure 5: *A program menu with Save Object selected by the mouse. This command is used to save a binary version of a program.*

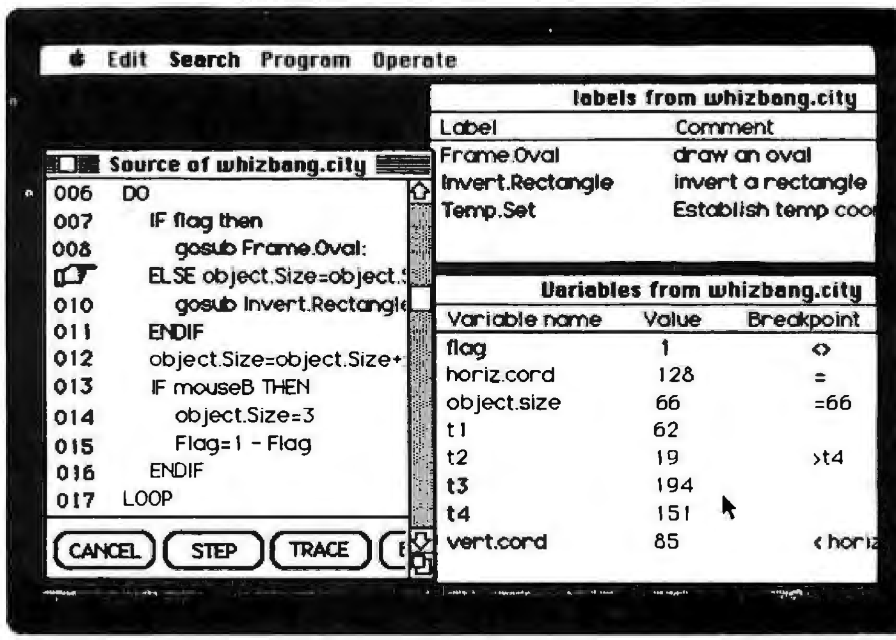

Figure 6: *The Macintosh BASIC Dynamic Debugger. The windows have been "shrunk" so that the major parts of all three would show. The Debugger adds line numbers for easy reference.*

Table 3 shows the results of some standard benchmark tests I ran on my Macintosh; the programs are shown in listing 5. I used the Macintosh's internal clock to do the timing; the smallest increment it reports is in full seconds. I ran each test five times; all but the Sieve were run for 5000 iterations. The results of two similar trials were sometimes different because the timing started in midsecond. ■

Macintosh BASIC will be available in the summer of 1984 at a price of $99. The language will be known officially as Macintosh BASIC. This would seem to preclude its use on other Apple computers. Microsoft BASIC also is available for the Macintosh; the price is $150.

Scot Kamins is senior writer for Technology Translated Inc. (1047 Sutter St., San Francisco, CA 94109), a technical writing firm.

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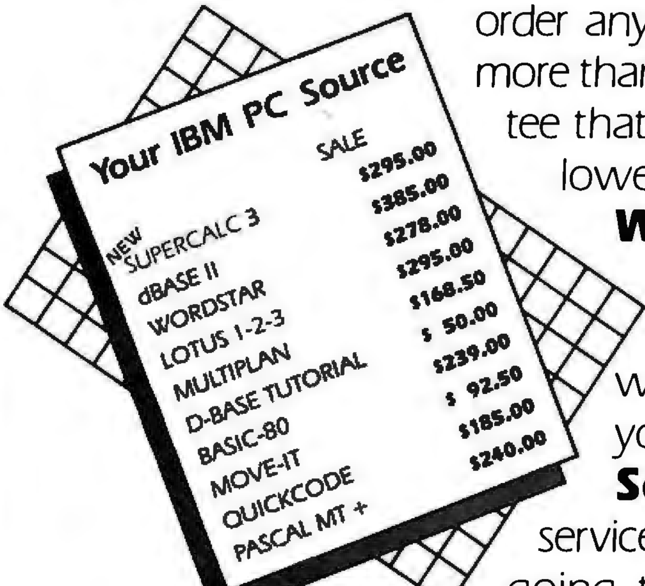

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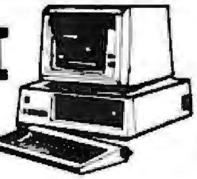

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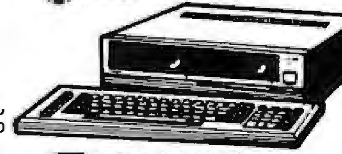

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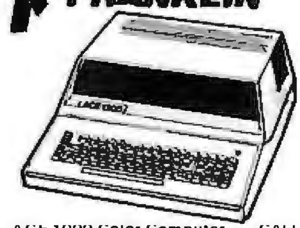

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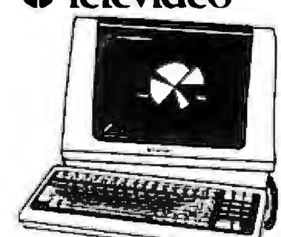

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Professional BASIC

Providing support for the 8087 coprocessor, and an array of debugging aids, this programming system makes BASIC a serious 16-bit tool

Donald P. George
Transamerica Occidental Life

Professional BASIC is a new version of the familiar BASIC language and was released initially for the IBM Personal Computer (PC) and PC compatibles. In terms of the language's features, Professional BASIC can be viewed as an extension of PC BASIC. By default, the product is also an extension of GW BASIC, the advanced version of the language Microsoft markets to the remainder of the world.

Morgan Computing Company, the publisher of Professional BASIC, has developed a product that extends the language in several unusual directions. The result is a program with outstanding, if not unique, educational qualities. Professional BASIC has the potential to favorably affect the process of learning the BASIC language and learning programming in general. Additionally, these same facilities serve as a nearly ideal environment for the debugging of nontrivial program code.

Morgan's product supports, in an unprecedented way, the visualization of program execution. It is not always true that a picture is worth a thousand words, but in learning to program, the adage is not only valid but conservative. Professional BASIC provides the pictures (in this case, windows) in ways that make understanding of the programming process, and the debugging of that process when it goes awry, clearer and much less confusing.

My intent in this article is to briefly explain the capabilities of Professional BASIC and throw in a few comments, positive and negative, along the way.

IBM PC BASIC Extended

Dr. Neil Bennett, the author of Professional BASIC, designed the language as a logical superset of PC BASIC. Almost all of the features included in IBM's (or Microsoft's) offering are included in this product. Most programs (Morgan says 95 percent plus) written in PC BASIC should run under Professional BASIC without change. The reverse is also true. However, Professional BASIC programs running under PC or GW BASIC would forgo many powerful and useful coding extensions.

Professional BASIC's extensions can be classified into several areas:

- improved program environment support
- new immediate commands
- visualization and debugging screens

The Improved Program Environment

Morgan has added much to the traditional BASIC environment. The language can use all of the memory available in your machine. For the IBM PC, this can amount to 640K bytes (if expansion boards are used). Compared with the 64K-byte limit almost universal for the language, this expanded memory is a welcome improvement.

Professional BASIC can use the Intel 8087 arithmetic coprocessor. This device is specifically designed for floating-point math operations, and its use speeds up program execution for those programs heavily involved with mathematical computations.

The product provides the ability to reference labels as well as statement numbers for all branching operators. For example, the following code is perfectly valid Professional BASIC syntax:

```
100 PROGRAM.MAINLINE.
    ROUTINE;
200 GOSUB INIT.PGM.FOR.EXEC
300 GOSUB LOAD.REFERENCE.
    TABLE
400 GOTO STANDARD.EXIT.
    ROUTINE
```

Note the long variable and subroutine names. In Professional BASIC, data names and labels have no practical length limit. The language supports names up to 320 characters long.

Professional BASIC is incrementally compiled; most implementations of BASIC are interpreted. Briefly, the difference is that, with an interpreter, each instruction of a program is converted into the equivalent machine instructions each time the BASIC instruction is executed. If you loop through a section of BASIC code 100 times, *each* one of those BASIC in-

structions is converted into machine code and executed 100 times.

The Professional BASIC incremental compiler passes the entire BASIC program through a line-by-line conversion process that produces an intermediate-level language. Morgan refers to this intermediate-level code as "microcode" or "pseudo code," but it more accurately resembles the p-code produced by many Pascal systems. This conversion process has some immediate advantages and one disadvantage. The advantages are increased speed of program execution (three to four times faster than PC BASIC) and checking of syntax and control errors as each line of source is entered so that syntax errors never halt program execution once it begins.

The disadvantage is the time it takes the compiler to make its second pass, just prior to program execution. My experience with the product is that this time frame is short enough not to be of concern: it's literally a few seconds for most programs.

Beep Beep

Another unusual feature of this product is a function called *dynamic syntax checking*. Professional BASIC constantly checks each character as you enter program code, and the system beeps when an invalid combination is entered. The system beeps again if the next keystroke is invalid. At the second unacceptable keystroke, the system dynamically generates a list of all the characters that are valid at this point in the syntax of the statement you are entering. (See figure 1 for an example of this display.)

An old computer adage says that the best way to correct an error is to not allow it in the first place. Morgan has built this fundamental design concept into the language.

New Commands at Command Level

Professional BASIC has several useful commands that can be entered when the program is in command level. The user can set breakpoints in a BASIC program by simply entering a line number or label name. When control passes to that statement, execution automatically suspends.

Another useful feature is the FIND command. If you enter a command like FIND TOTAL.CNT, Professional BASIC lists every line in the program that references TOTAL.CNT. To get a list of only those lines that assign TOTAL.CNT a value, use the Professional BASIC command FIND TOTAL.CNT=.

The FINETRACE facility, another unusual and useful feature, is available in both command and execution modes. If you have a complicated mathematical expression and need to see just how the expression is being evaluated, FINETRACE displays each intermediate value as the program goes from initial function to the final numeric result. (See figure 2 for an example.)

Windows: The Big Difference

The normal way to begin a program with the Professional BASIC system is to enter the RUN command. Now you can perform your first bit of magic. Just press L and you are in List Trace mode. The display clears and a screen full of your program code appears. A reverse video shades the instruction currently being executed. This bar dances around like crazy as it briefly highlights each executing instruction. Suddenly, loops are not an abstract concept anymore; they are a discernible pattern on the screen (see figure 3).

To stop all this kinetic motion, press the space bar and the tableau freezes. Every additional press of the

```
 10 TOTAL = FIELD1 F
TRY {AEIMOXaeimox^*/(+-=:' .}
```

Figure 1: *The system emits a beep when an invalid keystroke is entered. The second consecutive invalid character forces a display like the one above. In this example, the F is invalid in the assignment statement.*

space bar advances the program one instruction. Hold down the space bar and the action moves along at a stately pace. Press the Enter key and full-speed execution resumes.

To see what is taking place on the normal display screen, press P. Instantly, the screen is blanked and then replaced with the normal video display your program presents. Press L and you are back in List Trace mode again.

Pressing T activates the Chronological Trace window. This trace displays each line of the program as it is being executed and the values of any variables in that line of code. Just to make things more interesting, this trace can be run backward. Actually, the program doesn't run backward—previous trace values (which were saved) are simply displayed in reverse order—but the effect is the same. (See the right side of figure 5 for an example.)

The Array window lets the numeric keys serve as special scrolling keys.

But what about all the other variables in my program? you might be wondering; can I see them all as well? The answer, with Professional BASIC, is yes. By entering V, you can display the Variable window. This display shows every nonarray variable name in the program along with its data type and current value. The values change as the program executes, but a press of the space bar freezes the action.

As is the case with all the windows supported by Professional BASIC, the arrows and paging keys can be used to position the display for lengthy lists that won't fit on one video screen. (See figure 4 for an example of a Variable screen.)

The values of all array variables can be viewed with the Array window (A). This particular window lets the numeric keys serve as special scrolling keys that can scroll up to 10,000 lines with a single keystroke.

Professional BASIC provides windows to monitor WHILE and FOR/NEXT control structures, to display the nesting of GOSUBs, and to show

```
    10 DEFINT A-Z
    20 N = 0
    30 ALPHA = 648
    40 BETA = N * ALPHA / (N*4 - ALPHA*7)
    50 N = N+ 1
    60 ALPHA = ALPHA - 2
    70 GOTO 40
    RUN
In the line with the sequence number 40,
Integer Divide Error, 36288 / 0
Press Return for a slow motion replay
BETA=N*ALPHA/(N*4-ALPHA*7)
BETA=N*ALPHA/(252*4-ALPHA*7)
BETA=N*ALPHA/(1008-ALPHA*7)
BETA=N*ALPHA/(1008-144*7)
BETA=N*ALPHA/(1008-1008)
BETA=N*ALPHA/(0)
BETA=252*ALPHA/0
BETA=252*144/0
BETA=36288/0
Integer Divide Error, 36288 / 0
```

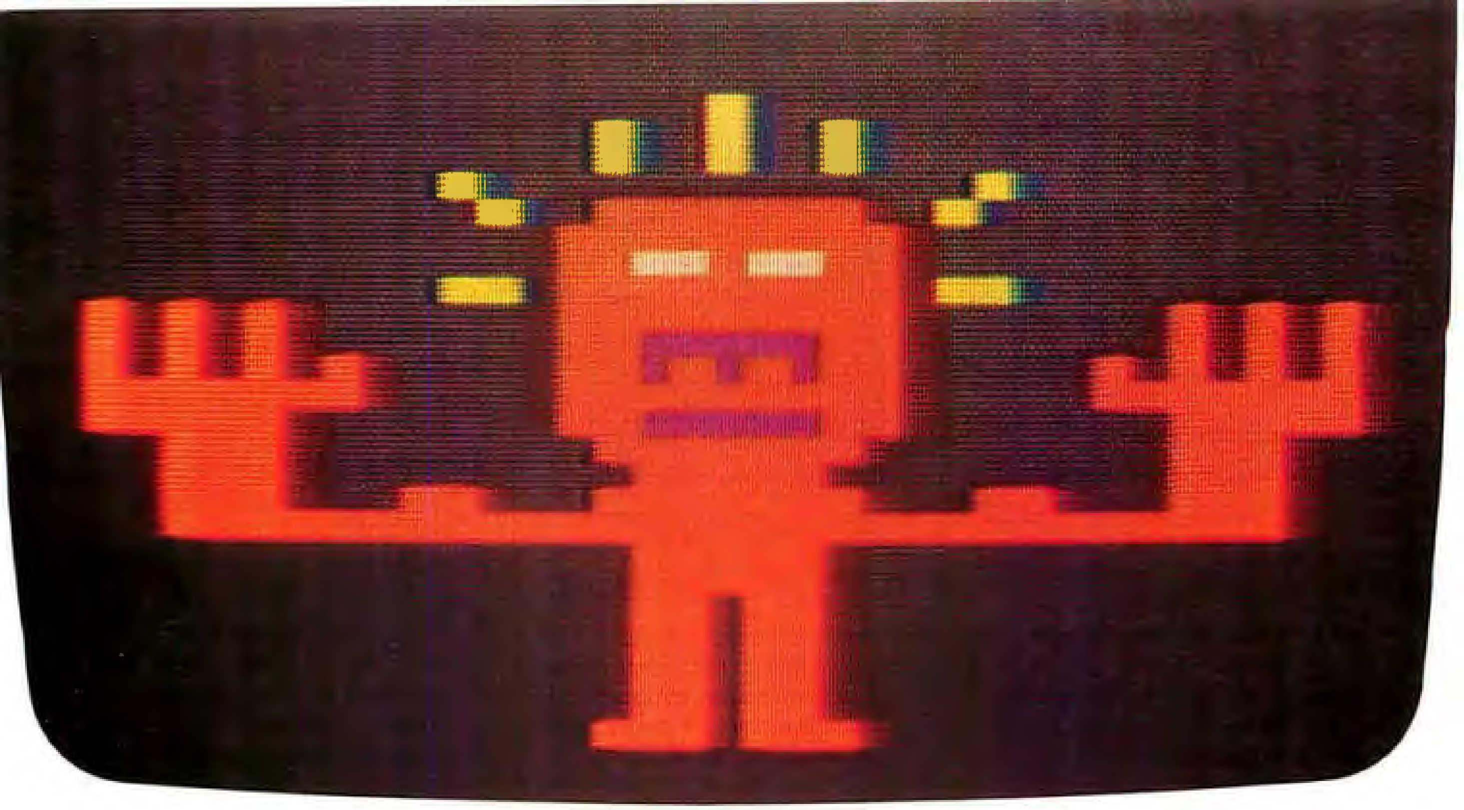
Figure 2: *Professional BASIC traps certain processing errors such as division by 0. For this kind of error, the FINETRACE facility automatically engages to help resolve the problem.*

```
50            1  070          x  s       1   step f 0 g 0  1  1 v 0
10    'SIMPLE EXAMPLE LOOP PGM
20    'AUTHOR.== DP GEORGE
30    '12/17/83
40    LOOP.CNT = 1
      MONTH    = 12
      YEAR     = 1983
50    LOOP.POINT;
60    IF LOOP.CNT = 20 THEN
        GOTO TERMINATION.ROUTINE
70    PRINT "LINE NUMBER";LOOP.CNT;
80    DAY = LOOP.CNT
90    DATE.FACTOR = DAY/365+MONTH/12+YEAR
100   PRINT DATE.FACTOR
110   LOOP.CNT = LOOP.CNT = 1
120   GOTO LOOP.POINT
130   TERMINATION.ROUTINE;'
140   CLS
150   PRINT "PROGRAM TERMINATING"
160   END
```

Figure 3: *An example of a List Trace window for a small representative program. The first line on the display is a status line that shows the current instruction number, the speed of execution (Morgan calls this a speedometer), the number of active FOR/NEXT and GOSUB statements, and several other data items. The current instruction is shown highlighted.*

```
160           1  000          x  s       1   step f 0 g 0  1  1 v 0
    sng DATE.FACTOR                                  1984.052

    sng DAY                                             19

    sng LOOP.CNT                                        20

    sng MONTH                                           12

    sng YEAR                                          1983

    int Z.LOCAL.COMBINED.SAVE.AREA.AND.CHECK.SW         99

          6 / 6
```

Figure 4: *An example of the Variable window display. The code* sng *stands for a single precision variable, and* int *stands for an integer variable.*



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Circle 194 on inquiry card.

```
130          162  000          x  s    lt   step f 0 g 0 1    1 vP0
10   'SIMPLE EXAMPLE LOOP PGM               145     70 PRINT "LINE NUMBER";
20   'AUTHOR == DP GEORGE                   146     80 DAY = LOOP.CNT
30   '12/17/83                                         DAY    18
40   LOOP.CNT = 1                           147     90 DATE.FACTOR = DAY/36
     MONTH     = 12                                    DATE.F  1984.049
     YEAR      = 1983                       148    100 PRINT DATE.FACTOR
50   LOOP.POINT;'                           149    110 LOOP.CNT=LOOP.CNT = 1
60   IF LOOP.CNT = 20 THEN                               LOOP.C  19
       GOTO TERMINATION.ROUTINE             150    120 GOTO LOOP.POINT
70   PRINT "LINE NUMBER";LOOP.CNT;          151     50 LOOP.POINT;'
80   DAY = LOOP.CNT                         152     60 IF LOOP.CNT = 20 TH
90   DATE.FACTOR = DAY/365+MONTH/12+YEAR    153     70 PRINT "LINE NUMBER";
100  PRINT DATE.FACTOR                      154     80 DAY = LOOP.CNT
110  LOOP.CNT = LOOP.CNT = 1                           DAY    19
120  GOTO LOOP.POINT                        155     90 DATE.FACTOR = DAY/36
130  TERMINATION.ROUTINE;'                             DATE.F  1984.052
140  CLS                                    156    100 PRINT DATE.FACTOR
150  PRINT "PROGRAM TERMINATING"            157    110 LOOP.CNT=LOOP.CNT = 1
160  END                                               LOOP.C  20
                                            158    120 GOTO LOOP.POINT
                                            159     50 LOOP.POINT;'
                                            160     60 IF LOOP.CNT = 20 TH
                                            161        GOTO TERMINATION.ROU
                                            162    130 TERMINATION.ROUTINE;'
```

Figure 5: *An example of a split-screen display. The left side of the display contains a List Trace window, and the right shows a Chronological Trace window. The current instruction is highlighted in both windows. The numbers 145–162 on the right correspond to the number of instructions executed so far in the program; they serve as a unique "serial number" for each line of the trace.*

the text of the microcode as it is being executed. With all this valuable information in separate windows, you will often need to be in two or more places at once.

All software has its limits. Professional BASIC supports simultaneously two windows only (split virtually down the center of the display screen). Considering the amount of data to be displayed and the constraint of an 80-character line, two windows on the screen at once is a practical limit. To split the screen, you press S. By default the second display brought up is the Variable window. You can change it to any other display by entering the code for the next desired window. Figure 5 shows a split-screen display with a List Trace window and a Chronological Trace window displayed simultaneously.

Learning BASIC with Professional BASIC

The facilities described previously should tempt the experienced programmer. The value of the various windows in debugging is fairly obvious. The inevitable result will be the production of code that, if not error- ree, contains fewer errors than would otherwise have been the case. And the code will be produced much more quickly, with a great deal less aggravation and frustration.

The role of Professional BASIC in the learning environment is equally (if not more) valuable. The appreciation felt by the experienced user for the inner workings of such BASIC

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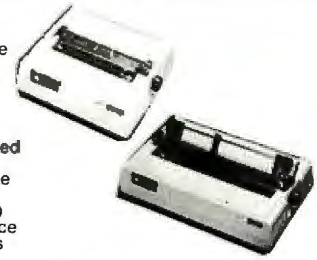

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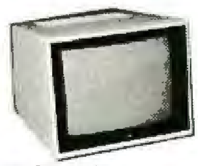

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constructs as FOR/NEXT, WHILE/WEND, GOSUB, etc., is not shared by the novice programmer. Professional BASIC provides a unique environment in which these strange objects come alive and their obscure antics become visual and obvious to the eye of the inexperienced user. This version of BASIC sets new standards for usability and "user friendliness."

Summary

Much more could be said about Professional BASIC. I would like to mention briefly a few more features.

- If you enter part of a data name or label and the @ character, Professional BASIC will complete the name.
- If you enter your code with multiple statements on a line and without "white space," the product will reformat the code (including indenting) automatically.
- Professional BASIC can produce a report in which each instruction that has not been executed in the testing process is underlined.
- Professional BASIC can produce a histogram report showing the relative frequency of execution of each instruction in the run.

As innovative and fully featured as this product is, there are some features that are missing (you just can't please some people). My list includes true subroutines, local variables, ALT-key macros, and an optional separate compiler. The language now requires a minimum of 256K bytes to run. My wish list would increase the memory requirements another notch or two, which may be why those features are not currently supported. ■

Professional BASIC is available from Morgan Computing Company, 10400 North Central Expressway, Suite 210, Dallas, TX 75231. The product costs $345.

Donald P. George (4643 Castleview Dr., Covina, CA 91724) is a project manager for training at Transamerica Occidental Life. He holds a B.A. in quantitative methods from Cal State Fullerton. He is the author of a book on BASIC programming scheduled to be published this spring.

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BASIC-09

A structured, incrementally compiled BASIC for Motorola MC6809-based microcomputers

Brian Capouch
St. Joseph's College

The BASIC-09 programming language, developed by the Microware Corporation in conjunction with Motorola, is a high-level program development system for the Motorola MC6809 microprocessor. It possesses syntactic features that have more in common with Pascal or C than with BASIC but maintains standard BASIC source code compatibility. The language runs under the OS9 operating system (OS), a modular, Unix-like OS designed to take advantage of the architectural features of the MC6809.

Interpretive Compilation

BASIC-09 is organized as a multipass compiler/interpreter. Each line of BASIC-09 source code is compiled incrementally into an intermediate code (called i-code by way of analogy to Pascal p-code). Lines of code can be entered either from the keyboard, via a built-in text editor, or from a mass-storage file. The compiler detects a large number of syntax errors and immediately reports them. This eliminates the annoying problem, presented by most compilers, of having to repeatedly resubmit programs to the compiler for detection of trivial spelling and punctuation errors. After a complete source code program has been entered, a second pass of the compiler checks the source code for context-dependent errors such as loop closures, line-number references, and type clashes. The twice-compiled i-code is then interpreted by an execution pass. A unique feature of the BASIC-09 run-time interpreter is an integral debugger, entered automatically whenever an error is detected. The debugger lets the user print and change the values of variables, trace, and single-step through a program. Breakpoints can be entered into the source code at compile time to let the user suspend execution of a running program and enter the debugger. Program execution may be resumed from the debugger after the breakpoints or after a nonfatal error.

The Workspace Concept

The BASIC-09 programming environment is organized into a *workspace*, a memory segment into which procedures load. BASIC-09, like Pascal and other high-level languages, uses named procedures that can call one another and pass parameters both by reference and by value. The workspace contains all procedures germane to a particular project. A statistics report indicates the amount of memory required by each procedure, both for its program code and for its data. Procedures can be loaded into and saved from the workspace into mass storage, either individually or in groups. The entire workspace may also be saved or retrieved as a unit.

Once a given program (defined to be one or more procedures) has been debugged and tested, the user may invoke a fourth pass of the compiler, a process known as *packing*. This pass of the compiler accomplishes several tasks. First, it removes all variable names and line-number references in order to compact the code and make it inaccessible for editing. It also makes the procedure available to other users via the OS9 memory module mechanism. A typical BASIC-09 environment includes several packed BASIC-09 modules available to every user of the system; all users can perform commonly required tasks such as terminal cursor addressing and file handling. When the BASIC-09 run-time system detects a procedure invocation, it first checks to see if the procedure is currently located in a user's workspace. If not, it checks memory to see if the procedure is a packed module currently in use by another user. If so, both users may share its program memory, with the only overhead required by the second user being that needed for local variable storage. If the procedure is not in memory, a search of the mass-storage directory checks for a packed procedure of the required name. If found, it automatically loads into system memory.

The OS9 Interface

Although the BASIC-09 programming system is powerful, it acquires additional power from its interface with the host OS9 operating system. OS9, functionally very similar to Unix, is a multiuser, multitasking OS with a highly modular organization. Several of its features are of interest

to the BASIC-09 programmer. First, BASIC-09 has a clearly defined interface to the OS, letting the user easily mix BASIC-09 code with assembly-language routines, as well as routines written in other high-level languages, such as Pascal, COBOL, and C. Because parameters are passed in a standard method using the MC6809 stack, users may easily write assembly-language routines to gain speed and efficiency.

Other OS9 system functions are available to BASIC-09 programs. Two particularly powerful functions are concurrent processing and pipelines. Any BASIC-09 procedure may at any time begin a new process as a *background,* or concurrent, process. This means that the new process will run simultaneously with the currently executing program. An example of the use of concurrent processing would be the listing of an output file to a printer. This listing can be done so the program that invoked the listing continues uninterrupted while the listing goes on in the background. A feature of this sort greatly enhances the user efficiency of BASIC-09 programs. Additionally, OS9 lets the user create program pipelines (see the text box on page 346) wherein the standard output from one program becomes the standard input of another. This makes it possible for useful modules to be mixed and matched to create special-purpose processors from simple building blocks. Packed BASIC-09 programs are fully pipeline compatible, meaning they may be used to implement pipelines (as in the examples given in the text box). Pipelines can also be created to pipe the output of standard system utility programs (such as directory listings) directly into the BASIC-09 I/O (input/output) system. This eliminates having to use temporary files and their associated overhead. BASIC-09 programs can also send their output down pipelines for processing by system utility programs or other BASIC-09 programs.

Named Procedures and Long Variable Names

BASIC-09 procedures and variables use similar naming conventions that are superior to almost every other language extant. Names are significant to 128 characters and follow the conventions in vogue for other high-level languages. Although case is not significant in BASIC-09 identifiers, it is recommended that lowercase characters be used where practical because BASIC-09 automatically capitalizes keywords. Since there is a case distinction between variables and keywords, it is easy to scan procedures for variables. Also, procedure calls can use string variables instead of constants to enable the passing of procedure names as parameters.

BASIC-09 has a full complement of control structures, similar to those found in other structured languages: WHILE-DO, REPEAT-UNTIL, FOR-NEXT, and LOOP-FOREVER are all implemented, as well as a multiline IF-THEN-ELSE statement. Additionally, a conditional EXITIF statement is available for all loops to provide a painless, structured way of exiting. Of the other high-level languages I am familiar with, only C has a superior means of leaving a loop without leaving behind a mess.

BASIC-09 recognizes five atomic data types: integer, byte, real, string, and Boolean. Strings may be from 1 to 255 characters in length. Variables may be declared to be of any of these types, or may be declared by default, using the same conventions as in standard BASIC. Users may also define their own complex types with the BASIC-09 TYPE statement, similar to the record-type structure in Pascal. Elements of a user-defined type may be any atomic data type or another user-defined type. Thus, it is possible to declare arbitrarily complex data structures that are nonrectangular and fitted to the nature of the data at hand. In addition to this "recursive" definition of data structures, BASIC-09 procedures may be called recursively as well.

Despite the structured capabilities of BASIC-09, it is also completely source-code compatible with almost all "standard" implementations of BASIC. Of course, as is commonly found, I/O statements are seldom compatible from one BASIC to another; BASIC programs would have to be minimally translated to run under BASIC-09. I will discuss the BASIC-09 I/O interface later.

A wealth of similarities exists between BASIC-09 and other high-level languages, but there are several points of difference. Two of these differences can be considered limitations of the current implementation of BASIC-09. First, there are no pointer data types as in other structured languages, which makes coding algorithms based on pointers impossible. Also, there is no means of declaring global variables. Consequently, data that must be known to all procedures in a program must be explicitly passed as parameters from procedure to procedure. The severity of this limitation is vehemently argued amongst BASIC-09 programmers; the issue is discussed more fully under Decoupling.

BASIC-09 programs communicate to the outside world through OS9 data paths, and as such they closely resemble the conventions used by Unix. File I/O, which can be directed to any file or device in the system, uses the byte-stream convention: all files look to BASIC-09 like a stream of bytes, and all devices look like files. Thus it is possible to debug programs by shunting file I/O to a terminal or printer by changing only a pathname inside the program. Normally file I/O is done in binary format, although the READ and WRITE commands do file I/O in ASCII (American National Standard Code for Information Interchange). When an internal-format GET or PUT is done, only the number of bytes specified by the data structure in question is retrieved. Files may consist of intermingled data of varying types and yet can still be accessed randomly. A SEEK command makes it possible to position a file pointer to any byte within a file. The sleek, optimized I/O system available under BASIC-09 is a major convenience of the language.

Pipelines and Filters

A Unix-inspired concept, pipelines *let the standard output of one program become the standard input of another program. If a program reads all its input from the standard input path and writes all its output to the standard output path, then it is called a filter. This is because the programs transform, or filter, the data passing through them. Filters may be hooked together to form pipelines in the OS9 operating system.*

In the pipeline shown in the figure below, the OS9 input redirection operator < is used to connect a data file to the first program in the pipeline, called EatBlanks (see listing 1). This program reduces consecutive runs of blanks to a single blank. The output of EatBlanks is then piped (using the pipeline operator !) into the standard input path of the filter program Lowerize (see listing 2), which changes all uppercase letters to lowercase using a logical OR function. Then, in certain conditions where a linefeed needs to be added to each carriage return, the filter program LF (see listing 3) is added to the series. This replaces every instance of the carriage-return character with a carriage return/linefeed pair. A properly filtered output then displays on the user's terminal. It could also be redirected to a mass-storage file or a device using the operator >. Note that packed BASIC-09 procedures are invoked by users in exactly the same way as system utility programs.

```
(This is contents of input file, named "testfile": )

    This       is  a test    of the ABILITY
of                  my little progRAM
to      eat Blanks AND change UpPeR CaSe       tO
                     lower.
- - - - - - - - - - - - - - - - - - - - - - - - - -
(OS9  command line to set up a pipeline: )

OS9:EatBlanks <testfile ! Lowerize ! LF
- - - - - - - - - - - - - - - - - - - - - - - - - -
(This is output to user's terminal: )

 this is a test of the ability
of my little program
to eat blanks and change upper case to
 lower.
```

An example of the pipeline capability of the OS9 operating system. The text between the dotted lines is the command line that funnels the text above through the three filter programs (listings 1, 2, and 3) to produce the text at the bottom.

Decoupling

As mentioned earlier, global variables cannot be used in BASIC-09. This has led to an ongoing debate in the BASIC-09 community regarding the severity of this limitation in the

Listing 1: *The filter program, EatBlanks. In all three listings, the numbers at the left represent the number of bytes of memory taken up by each line. BASIC-09 indents and capitalizes keywords automatically.*

```
0000      (* Filter program to eat consecutive runs of blanks from
0039      (* standard input
004B
004C      (* We must catch end-of-file, which causes an error
007F      ON ERROR GOTO 100
0085
0086      DIM InPath,OutPath:BYTE
0091      DIM Blank,Char,LastChar:STRING[1]
00A5
00A6      Blank=CHR$(32)
00AE      InPath=0
00B5      OutPath=1
00BC      (* Set LastChar to dummy value for first pass of loop
00F1      LastChar=CHR$($FF)
00FA
00FB      WHILE NOT(EOF(#InPath)) DO
0106        GET #InPath,Char
0110        IF Char=Blank AND LastChar=Blank THEN
0125          (* Do nothing
0132        ELSE
0136          PUT #OutPath,Char
0140        ENDIF
0142        LastChar=Char
014A      ENDWHILE
014E
014F 100  (* We do no extra error checking here
0177      END
```

Listing 2: *The filter program, Lowerize.*

```
0000      (* Filter to transform all uppercase letters to lower
0035
0036      (* EOF on input stream causes error, trap it
0062      ON ERROR GOTO 100
0068
0069      DIM InPath,OutPath:BYTE
0074      DIM Char:STRING[1]
0080      InPath=0
0087      OutPath=1
008E
008F      WHILE NOT(EOF(#InPath)) DO
009A        GET #InPath,Char
00A4        IF Char>="A" AND Char<="Z" THEN
00B9          Char=CHR$(LOR(ASC(Char),$20))
00C7        ENDIF
00C9        PUT #OutPath,Char
00D3      ENDWHILE
00D7
00D8 100  (* We do not check for errors here
00FD      END
```

Listing 3: *The filter program, LF.*

```
0000      (* Procedure to convert CR to CR/LF pair
0028      (* For use with processors that do not automatically follow CR w/LF
006B
006C      (* Error vector upon detection of EOF
0091      ON ERROR GOTO 100
0097
0098      DIM Char:STRING[1]
00A4      DIM CR:STRING[1]
00B0      DIM LineFeed:STRING[1]
00BC      DIM InPath,OutPath:BYTE
00C7
00C8      CR=CHR$($0D)
00D1      LineFeed=CHR$($0A)
00DA      InPath=0
00E1      OutPath=1
00E8
00E9      WHILE NOT(EOF(#InPath)) DO
00F4        GET #InPath,Char
00FE        IF Char=CR THEN
010B          PUT #OutPath,Char
0115          PUT #OutPath,LineFeed
011F        ELSE
0123          PUT #OutPath,Char
012D        ENDIF
012F      ENDWHILE
0133
0134 100  (* No error detection here, either
0159      END
```

language. It is undeniable that it presents obstacles when translating code from other structured languages. However, another school of thought applauds the total decoupling of modules that this convention requires. Many program bugs are introduced by procedures "knowing about" or being allowed to change variables where they shouldn't. Under BASIC-09 this can certainly happen, but it can never happen by chance. All data that passes back and forth between procedures must do so explicitly. According to this approach, the total decoupling enforced by BASIC-09 is actually a boon instead of a bane. Time alone will resolve this argument.

BASIC-09 and its parent OS9 operating system are available on a wide range of MC6809 configurations. Recently, the potential market for the system has been expanded at both ends. Radio Shack has begun to distribute OS9 and BASIC-09 for its low-cost TRS-80 Color Computer. This opens up a mass market and greatly expands the potential exposure that BASIC-09 will enjoy. At the other end of the spectrum, the GMX-III system from GIMIX Inc. (1337 West 37 Place, Chicago, IL 60609, (312) 927-5510) is a high-end system that features intelligent I/O processing, hardware memory protection, and up to 140 megabytes of hard-disk storage. Installations running this system support 12 to 16 users at 19,200 bits per second, making the system highly competitive with many minicomputers. The programmer efficiency offered by BASIC-09 is an invaluable component of these systems and promises an increasing number of users in days to come.■

Brian Capouch (RR1 Box 270, Monon, IN 47959) teaches computer science at St. Joseph's College in Rensselaer, Indiana, and operates a computer consultant's firm, Oikos Systems. Capouch holds a B.A. in Spanish from Indiana University and raises cows and chickens on his farm.

Designed by Robert Doggett, Larry Crane, Ken Kaplan, and Terry Ritter, BASIC-09 was first released in the spring of 1980. The language is available in a single version from Microware Systems Corporation, 5835 Grand Avenue, Des Moines, Iowa 50304, (515) 279-8844. The price is $195.00. BASIC-09's installed base is estimated at 10,000 units. Recent licensees include Tandy Corporation, Fujitsu, and Dragon Data.

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Soviet Microprocessors and Microcomputers

A review of Soviet literature indicates that most microcomputers in the U.S.S.R. are based on older American microprocessors

Ruth Heuertz
United Telephone Company

An examination of the state of the Soviet microprocessor industry reveals some startling, and some heartening, evidence about how the free exchange of information within our society affects our political and military position in the world community. It also reveals that copying another's innovation may not be a straightforward process.

The Soviet computer industry is moving ahead due largely to Yankee ingenuity. American integrated circuit (IC) processing equipment is used to some extent to produce Soviet microprocessors and support chips that often are direct imitations of American designs. The K580IK80 microprocessor is acknowledged by the Soviets as being an analog of the Intel 8080. The Elektronika-60 is extremely similar to the DEC (Digital Equipment Corporation) LSI-11/2. And the K589 bit-slice microprocessor series appears to be copied from the Intel 3000 series of chips. But despite their reliance on American innovation, the Soviets seem intent on developing their own microelectronics industry to produce the devices they need, rather than obtaining all those devices from the West.

According to current literature, Soviet microprocessors based on all the major logic technologies have been developed. However, all but one of these microprocessors are made of multiple chips. Soviet production techniques seem to be less sophisticated than, not as reliable as, and a few years behind their American counterparts.

I based my research of the Soviet development of microprocessors through 1982 primarily on Soviet literature available in the United States and literature from the U.S. government. A 1982 internal report for the U.S. electronics industry stated that the estimated yearly value of U.S. production of IC microprocessors and microcomputers is over $1 billion. The report states that in 1980, U.S. IC manufacturers produced 71.6 percent of the world's integrated circuits. The rest were produced in Japan (16.1 percent), Europe (5.9 percent), and the Soviet bloc and the rest of the world (6.3 percent).

Soviet Technology

There is some controversy about how the Soviets obtain the equipment and many of the innovations necessary for their advancement in computer technology, even though their strength in the theory of computation is well recognized. The U.S. Senate's Permanent Subcommittee on Investigations conducted hearings in 1982 on the transfer of high technology to the U.S.S.R. from the United States. During the hearings, several specialists testified on the state of the art of Soviet microelectronics and on the means by which the Soviets achieved it.

William Casey, director of the Central Intelligence Agency (CIA), reported to the subcommittee that

> The KGB has developed a large, independent, specialized organization which does nothing but work on getting access to Western science and technology. They have been recruiting about 100 young scientists and engineers a year for the last 15 years. They roam the world looking for technology to pick up. Back in Moscow there are 400 to 500 assessing what they might need and where they might get it—doing their targeting and then assessing what they get. It's a very sophisticated and far-flung operation.

The United States enacted an embargo to keep high-technology equipment from being exported to the Soviet bloc. The U.S. Export Administration Act of 1979 was intended to prevent the Soviet Union from using such equipment militarily.

The Soviets are said to have set up dummy corporations in the West for the purpose of purchasing sophisticated microelectronics manufacturing equipment. A 1981 CIA report, "Soviet Acquisition of Western Technology," told the subcommittee that Western microelectronics equipment acquisitions had permitted the

Soviets to "systematically build a modern microelectronics industry."

Dr. Lara H. Baker Jr., at the Los Alamos Laboratory of the Department of Energy, gave evidence before the subcommittee that the Continental Technology Corporation, based in West Germany and southern California, sent more than $10 million in American-made high-technology equipment to the Soviet Union from 1977 to 1980. Much of this equipment was intended for use in the manufacture and testing of semiconductors. Baker said the Soviets had "purchased clandestinely all the hardware they need for equipping a good integrated-circuit production plant. They showed no interest in purchasing production equipment that was not state of the art." Some of the equipment bought by the Soviets included saws for cutting silicon crystals, equipment for making masks for IC production, plotters to draw the circuits, etc. If these purchases were compiled, according to Baker, they'd include at least one complete IC processing plant.

The previously mentioned CIA report to the subcommittee stated that in 1982 the U.S.S.R. was considered to be at the stage of implementing its large-scale integration (LSI) technology to high-volume production. The U.S.S.R. had also sought Western aid in building two or three polysilicon plants that would more than double previous Soviet capability.

Production is normally done in the Soviet Union at specific enterprises, and research and development is done at others. But because of the restricted use of microcircuits (restricted perhaps to the military sector and not available in the civilian sector) and their rapidly changing nomenclature, microcircuits are developed and produced by computer equipment development enterprises. The Ministry of Instruments, Automated Equipment, and Control Systems (MINPRIBOR) coordinates the development and production of specialized LSI chips and microprocessors in the Soviet Union.

Printed-circuit boards are reportedly made, using domestic Soviet equipment, by the Electromechanical Plant Production Association in Leningrad. The boards are produced in two sizes, 1.5 by 110 by 124 millimeters and 1.5 by 140 by 235 millimeters. These are said to be as "good as the best world models." Perhaps the Soviets consider printed-circuit boards produced by Texas Instruments (TI) as some of the best: in early 1983, it was found that boards used in some Soviet ocean buoys are pin-for-pin compatible with those produced by TI. According to the previously cited specialists, these copies may have been developed using American equipment.

A coordinated production of microcomputer-related equipment is in progress in Council for Mutual Economic Assistance (CEMA) countries, led by the U.S.S.R. In 1982, production of SM 1420 and SM 1800 (based on an 8080-like processor) microcomputers was reportedly under way. At the thirty-fifth meeting of CEMA in 1981, a program was organized for the extensive development of microprocessor equipment during the 1982–1990 period. A total of 52 pilot microprocessor complexes and microprocessor-based devices are to be developed, and 29 complexes are to be produced before 1990.

The Soviet computer industry has been dependent on Western technology, using American equipment to produce copies of American computer chips. But the Soviets seem determined (at least in print) to reduce their reliance on American computer technology.

A Soviet Single-Chip Microprocessor

The K580IK80 is often described in Soviet and American literature as the Soviet analog of the Intel 8080 microprocessor. (Note the similarity in the numeric designations.) The K580IK80 is the only known single-chip Soviet microprocessor; the majority of Soviet microprocessors are made of multiple chips. Nine of the 10 known Soviet chip series are designed for the construction of multichip microprocessors.

The K580IK80 is a single-chip NMOS (negative-channel metal-oxide semiconductor) microprocessor that handles 8 bits of information at a time on a bidirectional data bus and can address up to 64K bytes of memory with its 16-bit address bus. It has one arithmetic and six general-purpose registers, 78 instructions, and eight priority interrupts. The instruction cycle time is 2 microseconds. The operating temperature range for the K580IK80 microprocessor is −10 to 70 degrees centigrade. The chip comes in a 48-pin package.

In comparing the Intel 8080 with these specifications for the K580IK80, the similarities are remarkable. The only differences are a slightly smaller temperature range for the Intel 8080 (0 to 70 degrees centigrade) and the packaging (the 8080 has 40 pins). The Soviet microprocessor is packaged in a hermetic 48-pin flatpack of white ceramic, sealed with a gold-tin lid. Such packaging is primarily used in the U.S. for high-reliability military devices; it is more expensive to produce than the black plastic case normally used for civilian purposes. According to L. W. Gallup, who analyzed the K580IK80 for Control Data Corporation, the 1980 Soviet construction processes for the K580IK80 were comparable to those used by American companies in 1977, judging by the line definitions of the metallization. Gallup reported, "This confirms my earlier estimates that their technology is about three years behind us."

As with the 8080, the Intel 8224 clock generator and driver was obtained by the Soviets and imitations of it produced. Several K580 chips perform functions similar to those of Intel chips. Table 1 is a comparative chart of chips with corresponding functions. Perhaps several of the K580 chips are direct copies of Intel chips. The similarity of names certainly reflects that.

The K580IK80 microprocessor is intended for controller and microcomputer applications, such as in the Soviet SM family of small electronic computers. Some microcomputers based on the 8-bit microprocessor are the Kristall-60 and the Elektronika-K1-10. Another machine probably using the K580IK80 is the SM 2138

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K580 Series	Intel 8080 Series
K580IK80 microprocessor	8080 microprocessor
K580IK24 clock driver	8224 clock generator and driver
K580IK51 serial peripheral interface	8251A programmable communication interface
K580IK53 interval timer	8253 programmable interval timer
K580IK55 parallel peripheral interface	8255 programmable peripheral interface
K580IK57 DMA chip	8257 DMA controller
K580IK59 interrupt processor	8259 interrupt controller

Table 1: *The Soviet K580 series of integrated circuit chips and Intel chips with corresponding functions.*

single-board computer (SBC), which uses an Intel 8080-based microprocessor. The SBC is used in the SM 50/40-1 microcomputer system and the MVS microcomputer development system. The MIKAM-2 controller has an SBC with a "functionally complete Intel 8080 microprocessor," probably meaning a K580IK80. V7 control microcomputers have the RMS/80 operating system, which is functionally similar to Intel's RMX/80 system and so might also use the K580IK80 microprocessor.

Elements of the SM 2138 module include a system bus driver, a 2K-byte static random-access read/write memory (RAM) block, a 4K-byte erasable programmable read-only memory (EPROM) block, a serial interface, a parallel interface for one input/output (I/O) peripheral or for two input or output peripherals, a programmable timer, and an interrupt controller.

The SM 1800 is a microcomputer whose characteristics sound as if an 8080-like chip is part of its processor board. It has an NMOS 8-bit microprocessor whose instruction cycle time ranges from 2.0 to 8.5 microseconds depending on the instruction executed. Maximum addressable memory is 64K bytes. The processor board has less RAM and read-only memory (ROM) on board than the SM 2138 in the SM 50/40-1 had. This board has 1K bytes of RAM and 2K bytes of ROM.

Soviet sources do not state specifically that the K580IK80 is used in the SM 50/40-1 and SM 1800 microcomputers. The SM 50/40-1 uses an "Intel 8080-based" microprocessor, which I presume to be the K580IK80. The characteristics of the SM 1800's central processing unit seem similar enough to those of the SM 50/40-1 to infer that the same microprocessor, namely the K580IK80, is used.

The Dzerzhinsk Experimental Design Office of the Khimavtomatika Scientific Production Association was developing analytical devices and systems using the K580IK80 microprocessor in 1982. Production of the SM 1800 was being organized in 1981 and was to have begun in 1982 through Soviet cooperation with other CEMA countries.

Statements about production figures for a particular Soviet device are rare in Soviet literature. In 1982, only 36 SM 50/40-1 microcomputer systems and 20 MVS systems were to be produced. These were to be punched-tape versions rather than disk versions. It was projected that 300 total systems would be produced in 1983 and 400 systems in 1984. That prediction was the only one in the Soviet sources I studied.

The Elektronika S5 Microcomputer Family

The S5 microcomputer line belongs to the larger Soviet Elektronika family. The microprocessors for this series seem to generally be con-

	S5-01	S5-02	S5-11	S5-12	S5-21
minimum number of boards	3	3	1	1	1
word length (bits)	16	16	16	16	16
number of instructions	31	31	31	31	31
speed (thousand operations per second)	10	10	10	10	150–200
chip series	K536	K536	K536	K536	K586
logic technology	PMOS	PMOS	PMOS	PMOS	NMOS
year introduced	1975	n.a.	1976	n.a.	n.a.
RAM in words	3K	4K	128K	128K	256K
ROM in words	2K	2K	1K	2K	2K
memory expansion (words)	to 28K bytes	to 32K*	to 32K	to 32K	to 32K
power consumption	90 W	100 W	10 W	30 W	20 W
power requirement (+V)	n.a.	n.a.	1.5, 5, 24	1.5, 5, 24	5, 12
dimensions (millimeters)	420 by 380 by 225	460 by 412 by 243	267 by 270 by 28.5	284 by 298 by 30	309 by 252 by 29
weight (in approximate kilograms)	n.a.	23 kg	1.2 kg	1.5 kg	1.2 kg
operating temperature (centigrade)	−10 to +50	−10 to +50	−10 to +50	−10 to +50	−10 to +50

* It is not clear if the Soviet literature is referring to words or bytes of memory.

Table 2: *A comparison of Elektronika S5 microcomputers.*

structed using multiple chips. One of the U.S.S.R. state prizes for science and technology was awarded to an unnamed group for their "creation and widespread introduction" of the Elektronika family.

The S5 microcomputers use the same instruction set and have 16-bit words and memory-mapped I/O channels. Data can be processed by the word or by the 8-bit byte. Four S5 models are constructed using the K536 series chips and one uses the K586 series chips. The K536 chip series is used in these S5 microcomputers: the S5-01, the S5-02, the S5-11, and the S5-12. The chips are built using PMOS (positive-channel metal-oxide semiconductor) logic technology. The Elektronika S5-01 was introduced in 1975 and the Elektronika S5-11 in 1976. The S5-02 is an update of the S5-01, as is the S5-12 of the S5-11.

The K586 NMOS chip series is used in the Elektronika S5-21 microcomputer, which was first mentioned in Soviet literature in 1980. The K586IK1 is a 16-bit chip in the K586 series of chips. In one article, it is said to be a single-chip microprocessor, but an earlier reference maintains that the K586IK1 is a 16-bit arithmetic-logic unit (ALU) chip requiring a control chip and other chips to make a 16-bit microprogrammable microprocessor.

Table 2 has been formed by choosing information from various sources in an effort to provide an overall representation of the Elektronika S5 family. These sources have at times been at odds; the information that seems most consistent to the S5 series as a whole has been included.

The S5-11 was to be used in *arms* and in automobile construction. (Such a reference to Soviet military usage is extremely rare among the Soviet sources.) Since the K536 chips are said to be available in ceramic-metal packages, and the S5-01, S5-02, S5-11, and S5-12 microcomputers are all built using this chip series, perhaps the S5-01, S5-02, and S5-12 have also been used in weapons. Applications for the S5 microcomputers were under development at the Volga-Vyatsk Regional Center for Debugging and Application of Microcomputers of the Family Elektronika S5.

An LSI-11/2 Look-Alike

The Elektronika-60 microcomputer system is one of the systems mentioned frequently in Soviet literature. It uses four 48-pin chips from the K581 NMOS chip series to make up the microprocessor. These chips are the K581IK1 (ALU) section, the K581IK2 control device, and the K581RU1 and K581RU2 microprogrammable memory. The microcomputer has 4K by 16-bit on-board RAM made up of chips that each store up to 512 words of 12-bit length. The K581 chip series was under production in 1980 and 1981.

The Elektronika-60's ALU handles 16-bit words, but the K581IK1 ALU chip is not cascadable. It has a speed (instruction cycle time) of 400 nanoseconds. There are eight 16-bit general-purpose registers and 26 microcode registers. The maximum address range is 32K by 16 bits. The mi-

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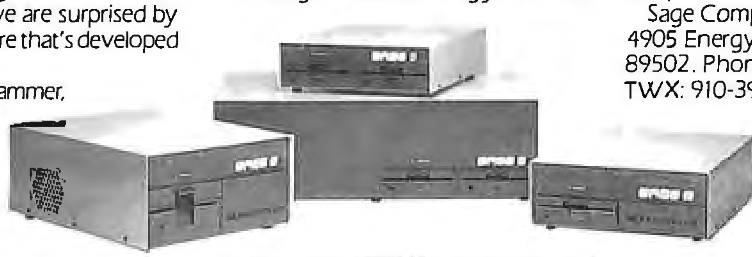

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	DEC LSI-11/2	Elektronika-60
technology	NMOS	NMOS
number of microprocessor chips	4	4
word size (bits)	16	16
on-board RAM	8K by 8 bits	4K by 16 bits
number of instructions	over 70	64 or 78
number of general-purpose registers	8	8
number of microcode registers	26	26
cycle time (nanoseconds)	350	approximately 400
instruction execution times (microseconds)	3.5 to 7.7	4.0 to 7.5
number of addressing modes	12	11
maximum address range	32K by 16 bits	32K by 16 bits

Table 3: *A comparison of the Elektronika-60 microcomputer with the DEC LSI-11/2.*

croprocessor module for the Elektronika-60 comes on a 280- by 240-millimeter board.

The Elektronika-60 was developed by the Ministry of the Electronics Industry (MINELEKTRONPROM) and by the Ministry of the Radio Industry (MINRADIOPROM). The Electronic Instrument-Making Association in Leningrad develops and produces LSI circuits and microprocessors that are used in several models of the Elektronika family. Products of the Association are distinguished by their high quality, and the number of products receiving the Soviet State Mark of Quality is increasing. This is apparently in opposition to typical Soviet production systems, which tend to stress quantity rather than quality. The microprocessor of the Elektronika-60 is provided by "the Leningraders" to a plant in Yerevan where controllers for the production of machining tools are made. This information suggests that the Elektronika-60's microprocessor is produced in Leningrad by the Association.

The Elektronika-60 reportedly uses an instruction set similar to that of the DEC LSI-11/2 microcomputer. The LSI-11/2 was a refined version of the LSI-11 introduced in 1975. This single-board computer was the first American microcomputer using 16-bit architecture, which at that time was appearing only in minicomputers. It had 8K bytes of resident RAM and its board size was 10 by 8.5 inches. The LSI-11/2 appearing in 1977 had its board size reduced to 5.2 by 8.9 inches but kept the same microprocessor features.

Further specifications of the LSI-11/2, according to DEC, are as follows. The LSI-11/2 microprocessor consists of four NMOS 40-pin packages: the data chip, the control chip, and two microcode ROM chips. Maximum address range is 32K by 16 bits or 64K by 8 bits. The LSI-11/2 microprocessor module contains eight 16-bit general-purpose registers. Cycle time is 350 nanoseconds.

Table 3 lists some shared characteristics of the Elektronika-60 and the DEC LSI-11/2.

Much of the information about the Elektronika-60 reads as though it came from a DEC manual about the LSI-11/2. And because of the similarities, I think that the Elektronika-60 is an imitation of the LSI-11/2. However, this speculation could be confirmed only through observation of an actual system.

The K589 Bit-Slice Series

The K589 chip series is used to build high-speed microprocessors and microcomputers using the bit-slice method to cascade ALU slices together for the required word length. The chips are of Schottky bipolar technology and use the pipelining principle in a K589 microprocessor complex.

The K589 ALU slice is the K589IK02 chip, which comes in a 28-pin package. Each slice has a 2-bit capacity. The chip has one accumulator and 11 general-purpose registers. Its speed is 70 nanoseconds, and the single power supply is +5 V. The K589IK02 has an operating temperature range of −10 to +70 degrees centigrade. The microprogram control chip is the K589IK01, also built using Schottky bipolar technology. Its speed is 60 nanoseconds. It comes in a 40-pin package.

The K589 line is strikingly similar to the Intel 3000 series. The 3001 microprogram control unit and the 3002 central processing element are built using Schottky bipolar technology. The 2-bit 3002 has one accumulator and 11 general-purpose registers. It has a minimum cycle time of 70 nanoseconds. The 28-pin chip requires +5 V.

The 3001 microprogram control unit can control 512 words of microprogram ROM. A pipelined configuration of these can be formed for 2048 microinstruction addressability. The minimum cycle time is 60 nanoseconds. The 3001 also comes as a 40-pin chip. (Table 4 lists chips of the K589 and Intel 3000 series with corresponding functions.)

Soviet microcomputer development has steadily become more technologically sophisticated. Beginning in 1975, PMOS technology was evident in the development of the Elektronika S5-01 microcomputer, which uses the K536 chip series. The Elektronika-60 microcomputer using series K581 chips, various microcomputers using K580 chips, and the Elektronika S5-21 using series K586 chips were of NMOS technology. The Elektronika-60 was said to be in use by 1979, the Elektronika S5-21 by 1980. In 1980, the K580 chip series was under production. I was unable to find definite development dates for these three series. Of the CMOS microcomputers, the Elektronika NTs-80-01 using the K588 chip series

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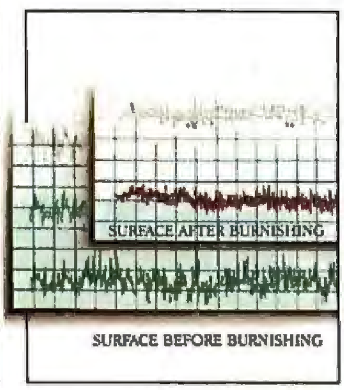

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K589 Series	Intel 3000 Series
K589IK01 microprogram control chip	3001 microprogram control unit
K589IK02 central processing element	3002 central processing element
K589IK03 fast carry unit	3003 look-ahead carry generator
K589IR12 buffer register	3212 multimode latch buffer
K589IK14 priority interrupt chip	3214 priority interrupt unit
K589AP16 bus driver	3216 noninverting bidirectional bus driver
K589AP26 bus driver with inversion	3226 inverting bidirectional bus driver

Table 4: *The K589 bit-slice series of chips and the equivalent Intel 3000 series of chips.*

reportedly was developed in 1979. The K589 series of Schottky bipolar technology and the K584 series of integrated injection logic (I^2L) technology seem to have been developed in the 1979–80 period.

Soviet microcomputer specialists use terminology differently from Americans. For example, the K580, K582, and K586 series are said to be single-chip microprocessors; the Elektronika NTs-80 microcomputers are referred to as having single-chip *microcomputers*. The term microcomputer is confused with microprocessor. Only the K580IK80 chip of the the K580 series is a single-chip microprocessor in the sense in which Americans use the term. The K580IK80 has the control unit and ALU on the same chip. But these other series—K582, K586, and K588 used in the Elektronika NTs-80 microcomputers—all have at least one control chip along with an ALU chip. In the West, these would be considered multiple-chip microprocessors.

Only one of the 10 known Soviet chip series includes a single-chip microprocessor—the K580IK80 of the K580 series chips. The overwhelming emphasis on multiple-chip microprocessors and microcomputers in the U.S.S.R. is surprising in comparison with an American emphasis on single-chip microprocessors. The Soviet multichip emphasis began with the Elektronika S5-01 bit-slice microcomputer. Soviet multichip microprocessors of NMOS, CMOS, I^2L, and Schottky bipolar technologies have since been developed and produced. A disadvantage of the multichip method is that more space must be made available for the chips on the circuit boards. An advantage is that the needed density per chip is much lower, requiring less sophisticated production equipment. Additionally, less reliable production techniques can be used since the rejection of one chip does not mean the loss of the entire microprocessor, as it would in producing single-chip microprocessors.

A compilation of some characteristics of known Soviet chip complexes is provided in tables 5 and 6.

Chip Series	Technology	Bit Groups	Single Chip	Multichip	Bit Slice
K536	PMOS	8		•	•
K580	NMOS	8	•		
K581	NMOS	16		•	
K582	I^2L	4		•	
K583	I^2L	8		•	•
K584	I^2L	4		•	•
K586	NMOS	16		•	
K587	CMOS	4		•	•
K588	CMOS	16		•	
K589	Schottky bipolar	2		•	•

Table 5: *A comparison of the different Soviet microprocessor series.*

Summary

How far is Soviet microcomputer technology behind American technology? L. W. Gallup at Control Data had direct access to the K580IK80 chip; comparing it to the Intel 8080, he concluded that Soviet chip construction technique was about three years behind American technique.

My research has relied on Soviet literature about their technology. Using this material, it is not easy to tell how advanced Soviet hardware is. In this kind of research, you must consider consistency in reports about particular devices to determine device characteristics. I have assumed that published reports about hardware lag behind actual developments; a truly up-to-date report on the Soviet state of the art cannot be attained through this approach. In considering how wide the gap between Soviet and American development is, it is interesting to note the appearance times of the Intel 3000 series and the corresponding Soviet K589 series. The 3000 series was introduced in the U.S. in late 1974. A specific introduction date for the K589 series is unknown; however, the earliest examples of its usage appeared in 1980 Soviet literature. If we assume that the K589 series was introduced in late 1979 or early 1980, that would indicate a five- to six-year lag in development time.

It is apparent that some Soviet equipment is copied from American

Chip Series	Incorporating Microcomputer	Word Length
K536	Elektronika S5-01	16
	Elektronika S5-02	16
	Elektronika S5-11	16
	Elektronika S5-12	16
K580	Kristall-60	8
	Elektronika-K1-10	8
	SM 50/40-1*	8
	SM 1800*	8
	MIKAM-2*	8
	V7*	8
K581	Elektronika-60	16
K582	n.a.	n.a.
K583	n.a.	n.a.
K584	n.a.	n.a.
K586	Elektronika S5-21	16
K587	Elektronika NTs-03	16
K588	Elektronika NTs-80*	16
	Elektronika NTs-80-01*	16
	Elektronika NTs-80-P1*	16
K589	n.a.	n.a.

* The series is presumed to be used in the particular microcomputer, but this is not specifically stated in Soviet literature.

Table 6: *Soviet microprocessor ser es and the computers they are used in.*

equipment. The K589 series appears to have been inspired by the Intel 3000 series. The Soviets acknowledge that the K580IK80 is an equivalent of the Intel 8080. The Elektronika-60 computer has been found to be almost the same as the DEC LSI-11/2.

The Soviet literature indicates that many K589 and K584 systems are in use but fails to mention any specific names. For the K582 series, only one description has been found of a microcomputer being constructed; for the K583 series, no descriptions have been found. This may mean that the K582 and K583 series were still under development, and the K589 and K584 series chips were considered state of the art in the U.S.S.R. in 1982. ■

The author did her research for this article at the University of Kansas as part of a Master's project. She would like to thank her advisor at the university, Professor Earl Schweppe.

Ruth Heuertz (c/o United Telephone Co., 6666 West 110th St., Overland Park, KS 66211) writes about Soviet technology. She has an M.S. degree in computer science and an M.A. degree in Soviet and Eastern European studies.

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Toward Standardized Video Terminals

ANSI X3.64 Device Control

A set of codes that promises to alleviate incompatibility

Mark L. Siegel
Televideo Systems Inc.

The video screen and the keyboard are the means by which most of us communicate with our computers, and they probably will remain the most efficient vehicles of human/computer interaction for years to come. A video-display terminal is a neat package containing both screen and keyboard, and even though many of today's personal computers contain integral keyboard and video-display circuits, discrete terminals are still the user workstation of choice in most large and many small computer systems. And most of the terminal operation principles involved apply also to the computers that integrate the functions.

Although conceptually and physically convenient, video-display terminals have suffered from software incompatibility. But a direct attack on this problem has been mounted by the development of a standardized method of controlling a terminal's functions. In this article I will describe the weapon of attack: the ANSI X3.64 standard.

Why a Standard is Needed

What happens when you sit down at a video-display terminal and hit the Return key? The cursor on the screen responds by moving to the left edge of the screen (and sometimes also down one line). You get the impression that the key directly controls the cursor's movement. But it doesn't. The depression of the key is sensed by the terminal's keyboard-control circuitry, which generates a unique binary code. The terminal's display-control hardware receives this code, interprets it, and recognizes it as a Return character; the hardware then moves the cursor's position accordingly. Or it can be even more complex: the key depression can be transmitted to a remote computer, where a program is running that analyzes the Return-key code and transmits back some different code to modify the screen contents in a way appropriate to some particular application.

The interface between a terminal and a computer must take account of compatibility on both the electrical level and the code (or logic) level. For specifying alphanumeric and other printable or displayable characters, all peripheral devices found in personal computer systems use the set of codes known as ASCII, the American National Standard Code for Information Interchange, shown in table 1. (ASCII's formal name is ANSI X3.4-1977; the abbreviation is pronounced "ass-key.") Some departures from the ASCII standard occasionally do occur in the character set, in some seldom-used characters, but differences typically emerge in how each manufacturer defines the codes for control functions.

Designers of terminals (and other peripheral devices) must choose a set of codes to indicate not only which alphanumeric characters are to be displayed or printed, but also to initiate various control functions: to move cursors, change colors, or scroll the display. Most video terminals use similar hardware to control the display. What may be different are the binary codes that have been chosen to represent the particular functions. Thus, even if one terminal's circuitry is almost identical to another's, if the control codes are different, the two terminals cannot be used with the same software.

ASCII was developed with the activities common to simple printers and teletypewriter terminals in mind. However, the variety of computer pe-

b7 / b6 / b5						0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
Bits	b4 ↓	b3 ↓	b2 ↓	b1 ↓	Column → Row ↓	0	1	2	3	4	5	6	7
	0	0	0	0	0	NUL	DLE	SP	0	@	P		p
	0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
	0	0	1	0	2	STX	DC2	"	2	B	R	b	r
	0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
	0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
	0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
	0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
	0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
	1	0	0	0	8	BS	CAN	(	8	H	X	h	x
	1	0	0	1	9	HT	EM	)	9	I	Y	i	y
	1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
	1	0	1	1	11	VT	ESC	+	;	K	[	k	{
	1	1	0	0	12	FF	FS	,	<	L	\	l	|
	1	1	0	1	13	CR	GS	–	=	M	]	m	}
	1	1	1	0	14	SO	RS	.	>	N	^	n	~
	1	1	1	1	15	SI	US	/	?	O	_	o	DEL

Table 1: *The American National Standard Code for Information Interchange (ASCII). This table is arranged to allow the character positions to be specified in column/row character notation, where the column number is the decimal equivalent of bits b7 through b5 in a 7-bit environment (or bits a8 through a5 in an 8-bit environment), and the row number is the decimal equivalent of bits b4 through b1 or bits a4 through a1, with b7 (or a8) the most significant bit in the character. Bit combinations are represented by the notation "column m, row n" or alternatively as "m/n", where m and n are the decimal column and row numbers, respectively. For instance, the capital letter A is the character in position 4/1.*

ripherals has grown considerably, and the number of different functions has also grown. The 32 control characters specified by the X3.4 ASCII standard became inadequate some years ago for providing peripheral control for the growing crop of new peripherals and their functions.

Many applications today demand sophisticated editing capability in video terminals, which therefore must have versatile screen-control functions. Users wish to be able to quickly move the active position (and its cursor) to any point on the display screen. Also, they need the flexibility for inserting and deleting single characters, strings of characters, or entire lines. These control functions go well beyond the scope of the ASCII standard.

When no control-function standard existed, designers of peripherals created their own control sequences using whatever combinations of ASCII control characters seemed handy. It was not uncommon, especially in devices with many functions, for designers to exhaust the existing set of control codes. They had to resort to using longer combinations or sequences of control characters. Because there were no common guidelines for creating these sequences, no two manufacturers used the same ones for the same purposes.

As a result, a programmer developing application software for a computer system always had to find out the specific codes used by the particular peripheral devices attached to the computer in order to write the device-driver portions of the software. This part of the program was therefore device-specific and would work properly with only that particular device or another that happened to employ the same control codes.

Application programs written to be used from a video terminal had to contain code to match that particular terminal's control sequences—often rendering the application programs useless on a system with a different terminal.

For vendors that design and manufacture all the components of their computer systems, use of proprietary terminal-control character sequences posed few problems. But vendors that assembled systems by purchasing processors, terminals, and peripherals from different manufacturers regarded the proliferation of control protocols as a plague, as did a group of manufacturers that sold terminals to those vendors. Expecting

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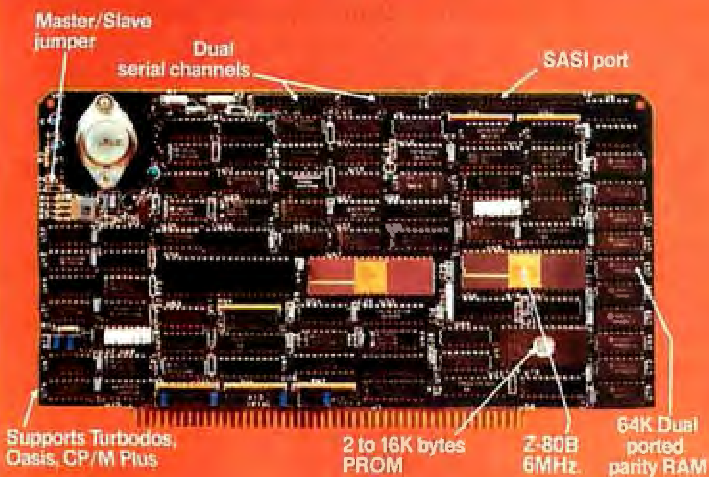

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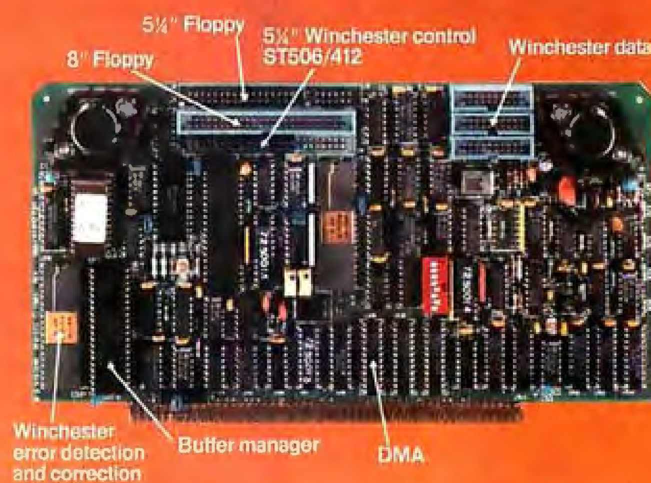

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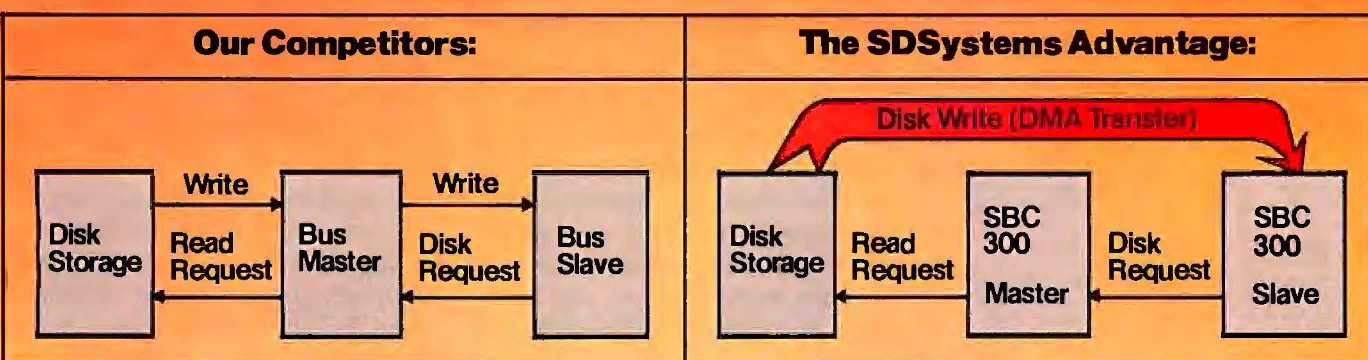

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to benefit greatly from the existence of a standard set of control sequences, these independent peripheral-device manufacturers became conspicuously interested during the late 1960s and early 1970s in the attempt by ANSI, the American National Standards Institute, to develop an American National Standard for device-control character sequences to be used together with the printing-character ASCII standard.

Development of the Standard

One surprise about American National Standards is that their use is largely voluntary. ANSI cannot of itself force any manufacturer to produce products conforming to them, but ANSI standards carry considerable weight because of ANSI's fair and methodical committee process and the organization's reputation for representing nearly all interested parties.

A key part of X3.64 is the control-sequence introducer.

The computer industry works through ANSI's Committee X3 on Information Processing Systems, which includes representatives of computer manufacturers (IBM, Sperry Univac, Digital Equipment, etc.), user groups and government agencies (General Services Administration, Air Transport Association, United States Department of Defense, National Bureau of Standards), and trade and professional associations (Institute of Electrical and Electronics Engineers, Association for Computing Machinery, etc.). All American National Standards pertaining to computers pass through committee X3. The standards bear numbers showing their committee origin, their sequence of adoption, and the year they were approved—like X3.64-1979. (For more detailed information, see reference 4.)

The X3 committee assigned the work of developing the device-control extensions to ASCII to the X3L2 Technical Subcommittee on Codes and Character Sets. The X3L2 committee was directed to devise a standard that could meet the foreseeable needs for input/output control of one entire class of peripheral devices, the ones that create images in two dimensions by character-oriented means. This class includes video-display terminals, character and line printers, and microfilm output printers. The standard was intended to be useful in a wide variety of applications, including on-line form filling by templates, typesetting, and word processing.

After the technical subcommittee finished its methodical process in 1977, and after the higher-level ANSI committees had voted approval in 1979, ANSI published the document called *ANSI X3.64-1979: Additional Controls for Use with the American National Standard Code for Information Interchange*.

The X3.64-1979 standard was formulated in compliance with the procedures for extending ASCII set forth in a standard called *ANSI X3.41-1974: Code-Extension Techniques for Use with the 7-Bit Coded Character Set of American National Standard Code for Information Interchange*. (The later date of the X3.4-1977 standard means that ASCII has been revised. American National Standards expire after five years; when that time has passed they are either revised, reaffirmed, or left for dead.) The International Organization for Standardization (ISO) later adopted a similar standard called *ISO DP6429: Additional Control Functions for Use with Character-Imaging Devices*—essentially a superset of X3.64-1979.

What the Standard Does

The X3.64-1979 standard was not intended to define the exact electronic features or characteristics of any particular peripheral device. In fact, the technical subcommittee did not anticipate that any single device would incorporate all of the controls defined by the standard.

What the standard does is specify control sequences for a great number of control functions, almost all that you would find in commercial computer equipment. The X3.64 docu-

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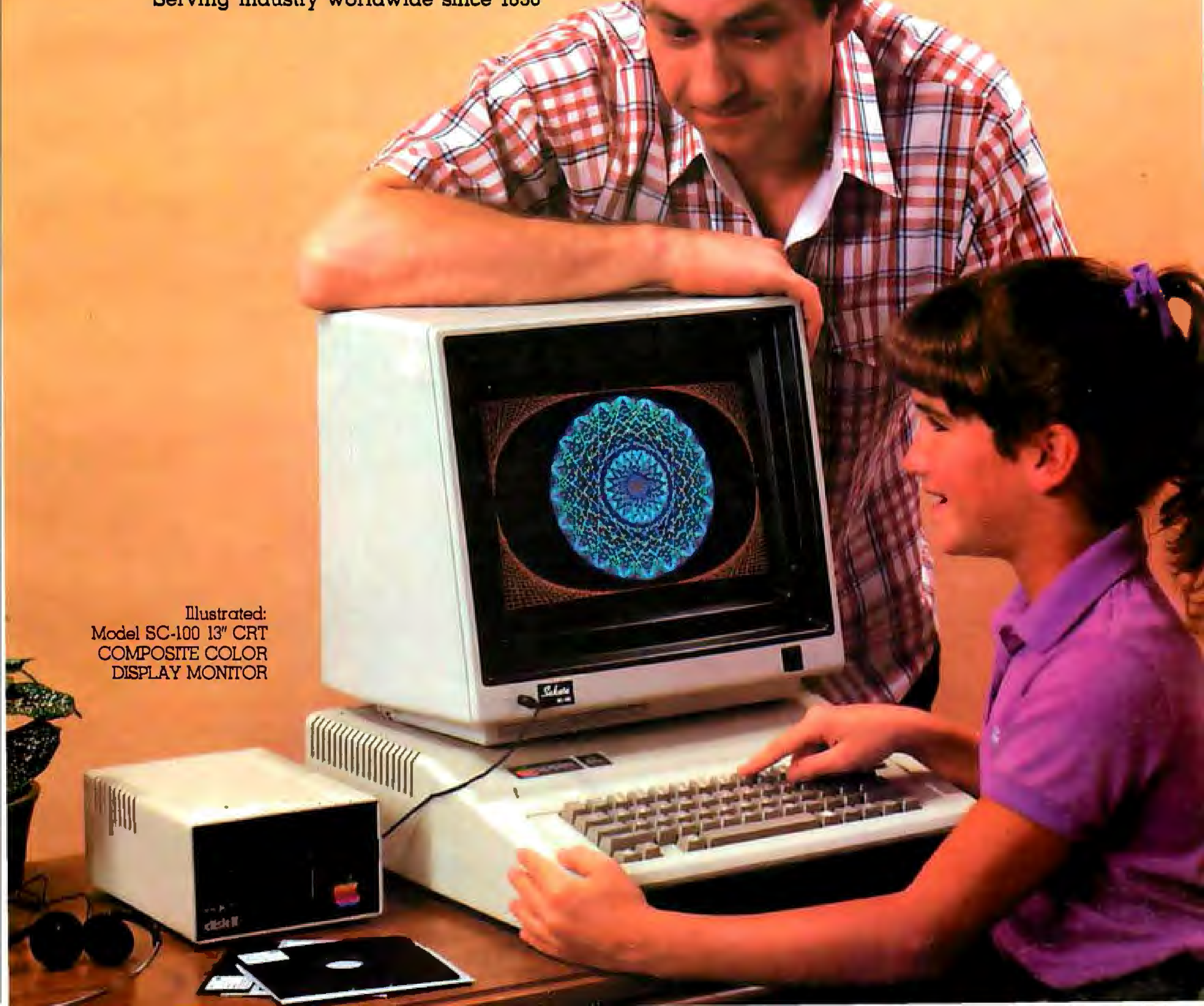

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2015 O'Toole Avenue, San Jose, California 95131 (408) 943-0596 ment describes 97 possible functions; the ones of interest to users of video terminals include changing the cursor and active position, editing lines, and scrolling.

All of the characters that appear in ANSI X3.64 control sequences are ASCII characters. These are used as an alphabet for building a set of control "words" that describe control functions.

One key part of X3.64 is the *control-sequence introducer* or CSI—a sequence of characters that unmistakably identifies the characters that follow as parts of a command to invoke one of the control functions of the video terminal (or other device). The regular CSI in X3.64 for the 7-bit ASCII character set consists simply of two ASCII characters: the Escape control character (decimal 27) and the left-bracket ("[") character. (There are also an as yet seldom-used 8-bit CSI and corresponding sequences.) In addition, some of the X3.64 functions are introduced by a single Escape character.

The characters that follow the CSI prefix in an X3.64 sequence specify the function that is to occur and supply numeric parameters that are needed by many functions. The characters following the CSI are either *intermediate* or *final*. In most cases any intermediate characters after the CSI supply the parameters, while the final character specifies the functions to occur, but sometimes intermediate characters assist in specifying the function. There is no limit to the number of intermediate characters. It is possible to build compound control sequences: a single CSI prefix can be followed by a string of parameters and function-specifying characters, with the codes for each function, separated by semicolons, used as delimiters.

Only printable characters are used in X3.64 sequences following the CSI; among other things, this allows the system to use the X-on and X-off (Control-S and Control-Q) nonprinting characters to start and stop the flow of data between the host computer and the terminal with no chance that the nonprinting characters will be mistaken by the terminal for function commands.

The major control functions available in X3.64 are listed in table 2. Each function is identified by both a name and a short mnemonic; the table is in alphabetical order by mnemonic.

The functions are affected by various modes that can be set (turned on) and reset (turned off) by means of the Select Mode and Reset Mode functions. A list of modes and the parameters to change them is given in table 3. The Select Mode and Reset Mode functions can also be used with reserved-private parameters in a specific video-terminal design to control modes and functions that exist only in that particular terminal.

A Function Example

Of all the command functions, the cursor controls are perhaps the most familiar, and of these the most versatile is the Cursor Position (CUP) sequence, which allows the cursor to be placed at any arbitrary position on the display screen. The format of the CUP, from table 2, is

Esc [*Pn* ; *Pn* H

The sequence begins with the ASCII Escape character (here abbreviated to "Esc") followed by the left bracket. These two together form the 7-bit control-sequence introducer. After the CSI comes a parameter, denoted here by *Pn*. In an actual command, this variable would be replaced by one or more ASCII characters for numeric digits, positions 3/0 through 3/9 in table 1. The first parameter is terminated by a semicolon, which leads to the second parameter—again, one or more ASCII characters representing digits. The "H" at the end of the command both terminates the second numeric parameter and specifies that the command is the CUP.

For instance, consider the sequence

Esc [17 ; 45 H

This sequence instructs the terminal to move the active position (and the cursor that indicates it) to the seventeenth line from the top of the screen and to the forty-fifth col-

Mnemonic	Name	Sequence	Default Value	Type or Mode
APC	Application Prog Command	Esc *Fe*		Delimiter
CBT	Cursor Backward Tab	Esc [*Pn* Z	1	EdF
CCH	Cancel Prev Character	Esc T		
CHA	Cursor Horizontal Absolute	Esc [*Pn* G	1	EdF
CHT	Cursor Horizontal Tab	Esc [*Pn* I	1	EdF
CNL	Cursor Next Line	Esc [*Pn* E	1	EdF
CPL	Cursor Preceding Line	Esc [*Pn* F	1	EdF
CPR	Cursor Position Report	Esc [*Pn* ; *Pn* R	1, 1	
CSI	Control Sequence Intro	Esc [		Introducer
CTC	Cursor Tab Control	Esc [*Ps* W	0	EdF
CUB	Cursor Backward	Esc [*Pn* D	1	EdF
CUD	Cursor Down	Esc [*Pn* B	1	EdF
CUF	Cursor Forward	Esc [*Pn* C	1	EdF
CUP	Cursor Position	Esc [*Pn* ; *Pn* H	1, 1	EdF
CUU	Cursor Up	Esc [*Pn* A	1	EdF
CVT	Cursor Vertical Tab	Esc [*Pn* Y		EdF
DA	Device Attributes	Esc [*Pn* c	0	
DAQ	Define Area Qualification	Esc [*Ps* o	0	
DCH	Delete Character	Esc [*Pn* P	1	EdF
DCS	Device Control String	Esc P		Delimiter
DL	Delete Line	Esc [*Pn* M	1	EdF
DMI	Disable Manual Input	Esc \		Fs
DSR	Device Status Report	Esc [*Ps* n	0	
EA	Erase in Area	Esc [*Ps* O	0	EdF
ECH	Erase Character	Esc [*Pn* X	1	EdF
ED	Erase in Display	Esc [*Ps* J	0	EdF
EF	Erase in Field	Esc [*Ps* N	0	EdF
EL	Erase in Line	Esc [*Ps* K	0	EdF
EMI	Enable Manual Input	Esc b		Fs
EPA	End of Protected Area	Esc W		
ESA	End of Selected Area	Esc G		
FNT	Font Selection	Esc [*Pn* ; *Pn* Space D	0, 0	FE
GSM	Graphic Size Modify	Esc [*Pn* ; *Pn* Space B	100, 100	FE
GSS	Graphic Size Selection	Esc [*Pn* Space C	none	FE
HPA	Horz Position Absolute	Esc [*Pn* '	1	FE
HPR	Horz Position Relative	Esc [*Pn* a	1	FE
HTJ	Horz Tab w/Justification	Esc I		FE
HTS	Horizontal Tab Set	Esc H		FE
HVP	Horz & Vertical Position	Esc [*Pn* ; *Pn* f	1, 1	FE
ICH	Insert Character	Esc [*Pn* @	1	EdF
IL	Insert Line	Esc [*Pn* L	1	EdF
IND	Index	Esc D		FE
INT	Interrupt	Esc a		Fs
JFY	Justify	Esc [*Ps* ; ... ; *Ps* Space F	0	FE
MC	Media Copy	Esc [*Ps* i	0	
MW	Message Waiting	Esc U		
NEL	Next Line	Esc E		FE
NP	Next Page	Esc [*Pn* U	1	EdF
OSC	Operating System Command	Esc]		Delimiter
PLD	Partial Line Down	Esc K		FE
PLU	Partial Line Up	Esc L		FE
PM	Privacy Message	Esc ^		Delimiter
PP	Preceding Page	Esc [*Pn* V	1	EdF
PU1	Private Use 1	Esc Q		
PU2	Private Use 2	Esc R		
QUAD	Typographic Quadding	Esc [*Ps* Space H	0	FE
REP	Repeat Char or Control	Esc [*Pn* b	1	
RI	Reverse Index	Esc M		FE
RIS	Reset to Initial State	Esc c		Fs
RM	Reset Mode	Esc [*Ps* I	none	
SD	Scroll Down	Esc [*Pn* T	1	EdF
SEM	Select Edit Extent Mode	Esc [*Ps* Q	0	
SGR	Select Graphic Rendition	Esc [*Ps* m	0	FE
SL	Scroll Left	Esc [*Pn* Space @	1	EdF
SM	Select Mode	Esc [*Ps* h	none	
SPA	Start of Protected Area	Esc V		
SPI	Spacing Increment	Esc [*Pn* ; *Pn* Space G	none	FE
SR	Scroll Right	Esc [*Pn* Space A	1	EdF
SS2	Single Shift 2 (G2 set)	Esc N		Introducer
SS3	Single Shift 3 (G3 set)	Esc O		Introducer

Table 2: *The 7-bit device-control codes in American National Standard X3.64-1979. A given peripheral device may not respond to all codes, but most ANSI-compatible video terminals work with a subset of the most popular functions.*

Table 2 continued on page 373

Table 2 continued:

SSA	Start of Selected Area	Esc F		
ST	String Terminator	Esc \		Delimiter
STS	Set Transmit State	Esc S		
SU	Scroll Up	Esc [*Pn* S	1	EdF
TBC	Tab Clear	Esc [*Ps* g	0	FE
TSS	Thin Space Specification	Esc [*Pn* Space E	none	FE
VPA	Vert Position Absolute	Esc [*Pn* d	1	FE
VPR	Vert Position Relative	Esc [*Pn* e	1	FE
VTS	Vertical Tabulation Set	Esc J		FE

Abbreviations:

EdF editor function
FE format effector
Gs is a graphic character appearing in strings (Gs from 2/0 to 7/14)
Ce is a control represented as a single bit combination in the C1 set of controls in an 8-bit character set
Fe is a Final character of a 2-character Escape sequence that has an equivalent representation in an 8-bit environment as a Ce (Fe from 4/0 to 5/15)
Fs is a Final character of a 2-character Escape sequence that is standardized internationally with identical representation in 7-bit and 8-bit environments and is independent of the currently designated C0 and C1 control sets (Fs from 6/0 to 7/14)
Pn is a numeric parameter in a control sequence, a string of zero or more characters from 3/0 to 3/9
Ps is a variable number of selective parameters in a control sequence with each selective parameter separated from the other by the code 3/11 (which usually represents a semicolon); *Ps* from 3/0 to 3/9 and 3/11

Parameter Character	Mode Mnemonic	Mode Function
3/0		an error condition
3/1	GATM	guarded-area transfer mode
3/2	KAM	keyboard action mode
3/3	CRM	control representation mode
3/4	IRM	insertion/replacement mode
3/5	SRTM	status-reporting transfer mode
3/6	ERM	erasure mode
3/7	VEM	vertical editing mode
3/8		reserved for future standardization
3/9		reserved for future standardization
3/10		reserved separator for parameters
3/11		standard separator for parameters
3/12		reserved for private (experimental) use
3/13		reserved for private (experimental) use
3/14		reserved for private (experimental) use
3/15		reserved for private (experimental) use
3/1 3/0	HEM	horizontal editing mode
3/1 3/1	PUM	positioning unit mode
3/1 3/2	SRM	send/receive mode
3/1 3/3	FEAM	format effector action mode
3/1 3/4	FETM	format effector transfer mode
3/1 3/5	MATM	multiple area transfer mode
3/1 3/6	TTM	transfer termination mode
3/1 3/7	SATM	selected area transfer mode
3/1 3/8	TSM	tabulation stop mode
3/1 3/9	EBM	editing boundary mode
3/1 3/10		reserved separator for parameters
3/1 3/11		standard separator for parameters
3/1 3/12		error condition—unspecified recovery
3/1 3/13		error condition—unspecified recovery
3/1 3/14		error condition—unspecified recovery
3/1 3/15		error condition—unspecified recovery
3/2 3/0	LNM	line-feed/new-line mode (not in ISO DP6429)
3/2 3/1 . . . 3/9 3/9		reserved for future standardization
3/12 3/0 . . . 3/15 3/15		reserved for private (experimental) use

Table 3: *ANSI X3.64 mode-changing parameters used with the Select Mode and Reset Mode functions. ASCII characters are specified by column/row notation (see table 1).*

umn across from the left. The numbers consist of the ASCII characters for one, seven, four, and five—all parameters in X3.64 are assumed to be in decimal radix. There are spaces shown here between the elements of the sequence for clarity, but no spaces should actually appear in a real command except where explicitly required. If no parameters are supplied, the command is executed with both parameters defaulting to 1, and the cursor goes to the home position.

Flexibility and Expansion

Functions similar to CUP exist to move the cursor to any position along a given line or down a column. Other functions can move the cursor relative to the position it has when the command is received. Editing functions include sequences to control the insertion or deletion of individual characters, strings of characters, or complete lines of text. More advanced functions allow the display screen to be divided into special-purpose fields that can be highlighted, protected against change, or even rendered invisible.

Other functions exist to specify operations that you'll hardly ever find in a video-display terminal. That should be no real surprise, because no one ever intended that all peripheral devices should implement every part of the X3.64 standard. But the functions are there for use by flatbed plotters, typesetting equipment, and whatever else gets invented.

The X3L2 committee left room for future expansion by reserving certain codes. Conscientious designers of terminals and software will take steps to ensure future compatibility: spelling out exactly which codes are used, avoiding the reserved codes, and not assigning nonstandard functions to control sequences used in the standard. Avoiding conflict shouldn't be too hard: using only one intermediate character in control sequences, over 1000 private function codes can be constructed.

The development and increasing use of the X3.64 device-control standard promises to allow near-complete compatibility between different makes of video terminals. The control sequences for all of the most common functions will be the same in any two video terminals that conform to the standard, even if the two terminals were designed years and continents apart. A programmer writing application software can use a set of ANSI X3.64 control sequences and remain confident that the software will work properly with any terminal that meets the standard. And users will have greater range than ever before in choosing a video terminal that can work with their systems.

There's not room here to cover all the details of all the functions in this article. To use the standard, you'll need a copy of the X3.64-1979 document, which you can order from ANSI, 1430 Broadway, New York, NY 10018 for $17 plus $4 for postage. Take time to study it; and use table 2 in this article as a quick reference.■

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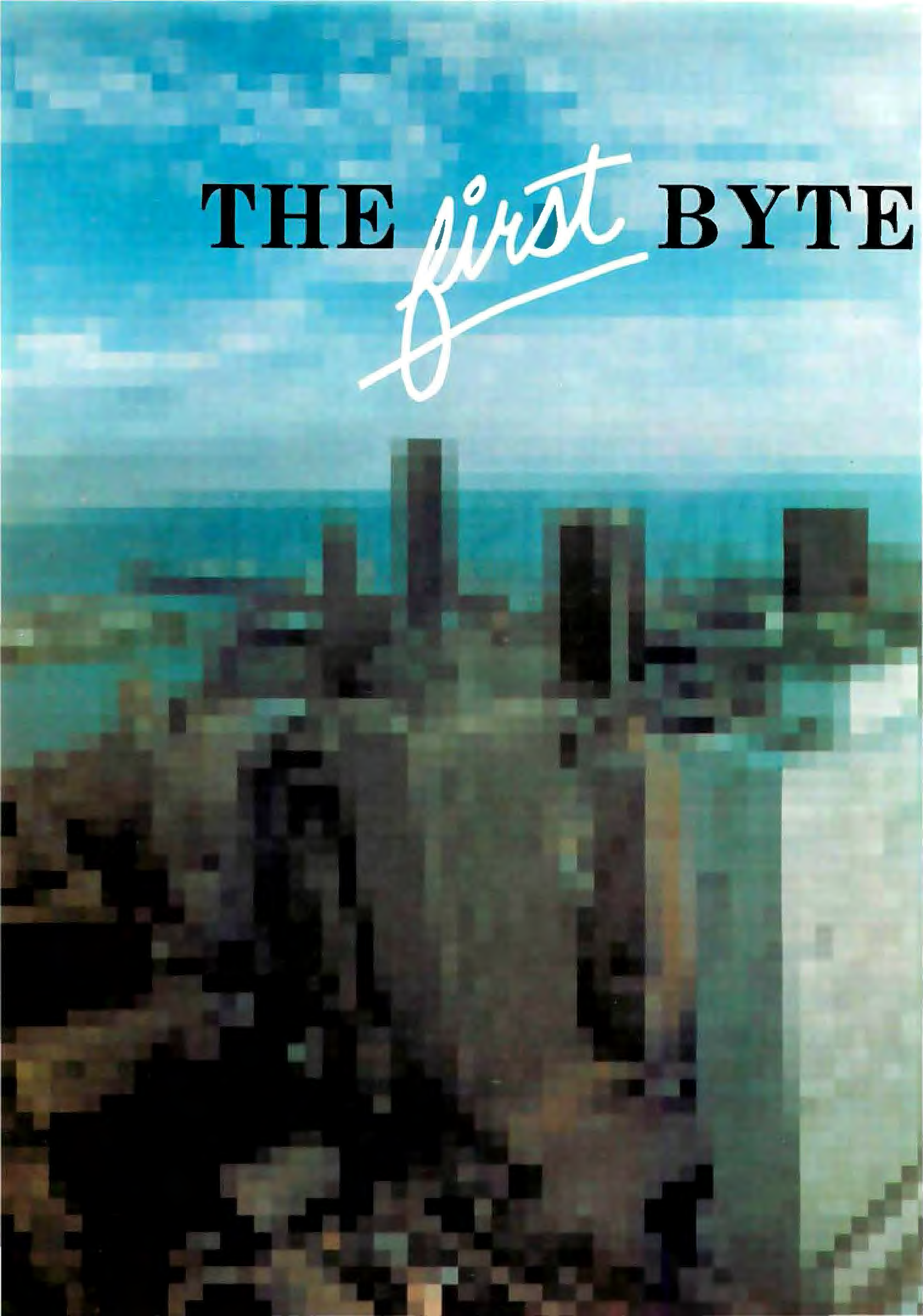
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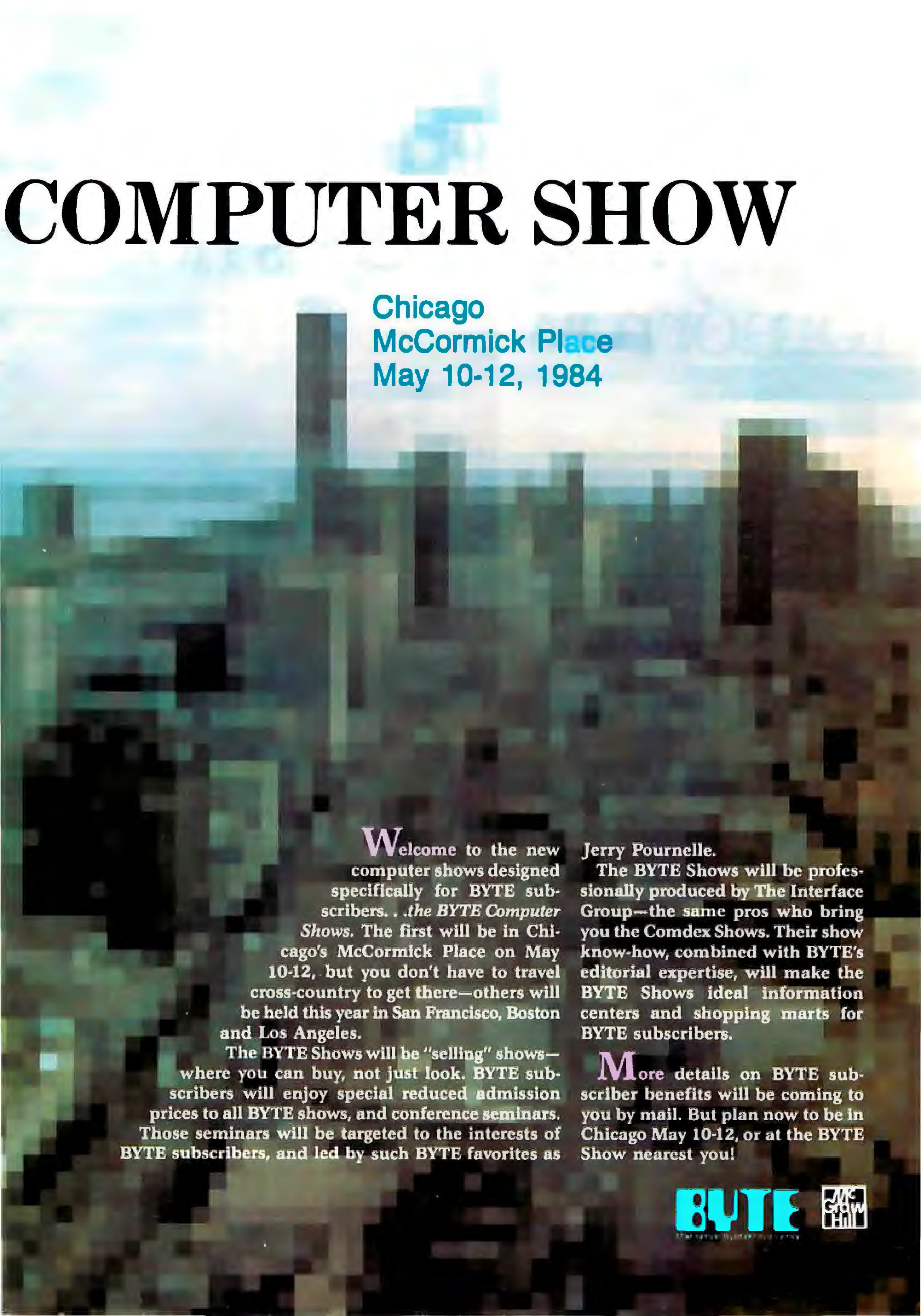

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A VIC-20/Commodore 64 Terminal Emulator

This versatile program puts you in touch with mainframes

John P. Russo
Indiana University

I purchased a VIC-20 because I was interested in using it as a terminal (via a modem) with a Prime 550. The terminal program that came with the modem had a number of serious defects. It had no cursor, uppercase characters only, and backspacing wasn't displayed on my screen. After a few weeks of frustration, I began to modify the program and, eventually, I completely scrapped it and started over. The result is the program in listing 1. It has a combination of features not available, to my knowledge, on other terminal programs. These include:

1. compatibility with expanded and unexpanded VIC-20s as well as the Commodore 64
2. one keystroke log-in
3. uppercase-only key
4. time since log-in available with one keystroke
5. choice of blinking or steady cursor
6. capability for local text files on disk or cassette to be sent to mainframe
7. automatic repeat on all keys

Because the program is written in BASIC, it can be easily modified. Yet, in practical terms, it runs as fast as machine-language programs, because it keeps up with the 300-bps (bits per second) transmission rate used by many modems. I had to work a bit to make the program efficient enough to achieve this speed, so you should be careful if you change lines 600–653.

Because no one types at a speed of 30 characters per second, the only real challenge for the program is in keeping up with long transmissions from the mainframe. Early versions of the program were not successful in this regard and the 500-byte receiving buffer occasionally overflowed. However, after I introduced a number of refinements, the program easily handled transmissions of any length. The only place where the speed of BASIC limits the program significantly is in sending files. The culprit here is the GET statement, which is slow in retrieving information from either tape or disk.

How the Program Works

The basic structure of the program is simple. After opening a communications channel, initializing, and printing the function-key menu, the program awaits user input. If a function key is pressed (see Function Keys), the routine performs the indicated operation and returns to await input. If that input is a character then the character is dispatched. Let's assume that the program is running and you type an "a." Immediately, the code for this character is sent over the phone lines to the mainframe. In the full-duplex mode, the mainframe echoes back the received character and it is printed on your screen so that you can see that all is well. The program then continues to look for incoming characters, but if none arrives, it turns its attention once again to the keyboard and the cycle starts again.

There is a slight complication to the send-receive operation, however. Commodore uses different character codes than do mainframes, most of which use ASCII (American National Standard Code for Information Interchange) codes. Thus, the program must perform conversions before sending characters or printing received characters. The arrays S$ (sending array) and R$ (receiving array) accomplish this task quickly and efficiently.

For example, suppose that a lowercase "a" (ASCII 97) is typed and is

Listing 1: *The terminal-emulator program for VIC-20 and Commodore 64 computers.*

```
 10  REM  *************************************************************
 15  REM  *                                                           *
 20  REM  *      TERMINAL EMULATOR FOR VIC-20 AND COMMODORE 64        *
 25  REM  *                                                           *
 30  REM  *      AUTHOR:  JOHN  RUSSO                                 *
 35  REM  *                                                           *
 50  REM  *      DATE:     JANUARY,1983                               *
 60  REM  *                                                           *
 70  REM  *************************************************************
 75  REM
 80  REM
 85  REM  *************************************************************
 90  REM  * OPEN 7 BIT FULL DUPLEX RS232 CHANNEL AND DIMENSION ARRAYS *
 95  REM  *************************************************************
100  REM
110  LET BAUD$   = CHR$(38)
115  LET DUPLEX$ = CHR$(160)
120  OPEN 5,2,3, BAUD$ + DUPLEX$
130  DIM R$(127), S$(255)
140  REM  *************************************************************
150  REM  *        INITIALIZE VARIABLES AND DEFINE CONSTANTS          *
160  REM  *************************************************************
170  LET QUOTES$     = CHR$(34)
175  LET BACKSPACE$ = CHR$(157)
180  LET ERASE$      = " " + BACKSPACE$
190  LET DARK$       = CHR$(162) + BACKSPACE$
200  LET CURSR$      = DARK$
205  LET TIME$       = "000000"
210  LET CAP%        = 32
220  LET LGIN$       = "YOUR LOGIN MESSAGE"
225  FOR K = 32 TO 64
230  LET S$(K) = CHR$(K)
235  LET R$(K) = CHR$(K)
240  NEXT
245  FOR K = 65 TO 90
250  LET S$(K)      = CHR$(K + CAP%)
255  LET R$(K)      = CHR$(K+128)
260  LET S$(K+128) = CHR$(K)
265  LET R$(K+32)  = CHR$(K)
270  NEXT
275  FOR K = 91 TO 95
280  LET S$(K) = CHR$(K)
285  LET R$(K) = CHR$(K)
290  NEXT
310  S$(13)  = CHR$(13):  R$(13)  = CHR$(13) :  S$(148) = CHR$(13)
315  S$(20)  = CHR$(8) :  R$(8)   = CHR$(20) :  S$(160) = CHR$(32)
320  S$(171) = CHR$(17):  S$(174) = CHR$(19) :  S$(175) = CHR$(16)
330  S$(188) = CHR$(3) :  S$(179) = CHR$(125):  R$(125) = CHR$(179)
340  R$(92)  = CHR$(94):  R$(95)  = CHR$(164)
345  PRINT CHR$(14)
350  REM *************************************************************
360  REM *                  PRINT  HELP  MENU                        *
365  REM *************************************************************
370  PRINT CHR$(147)
380  PRINT "USE FUNCTION KEYS"
390  PRINT "   AS FOLLOWS"
400  PRINT: PRINT
410  PRINT "F1: PRINT THIS MENU "
420  PRINT
430  PRINT "F2: SEND TEXT FILE  "
440  PRINT
450  PRINT "F3: TIME SINCE LOGIN  "
460  PRINT
470  PRINT "F4: KEY REPEAT ON-OFF "
480  PRINT
490  PRINT "F5: SEND LOGIN MESSAGE  "
500  PRINT
510  PRINT "F6: CURSOR (NO)BLINK"
520  PRINT
530  PRINT "F7: CAPS ON-OFF "
540  PRINT
550  PRINT "F8: CHANGE SCREEN "
560  PRINT
570  PRINT "USE COMMODORE KEY AS   CONTROL KEY"
575  REM  *************************************************************
580  REM  *               RECEIVING AND SENDING LOOPS                 *
590  REM  *************************************************************
600  PRINT CURSR$;
605  IF BLINKOFF THEN 625
610  LET COUNT% = COUNT% + 1
615  IF COUNT% = 10 THEN LET CURSR$ = DARK$
620  IF COUNT% = 20 THEN LET CURSR$ = ERASE$ :  LET COUNT% = 0
625  GET CH$ : IF CH$ = "" THEN 650
630  LET CCODE%  = ASC(CH$)
635  IF CCODE% > 132 AND CCODE% < 141 THEN 655
640  PRINT#5, S$(CCODE%);
```

Listing 1 continued on page 382

sent to the mainframe without modification. In reality, the Commodore code ("a" = 65) for this character would be sent. The mainframe would interpret the sent character using standard ASCII codes, under which ASCII 65 = "A." Thus, if no conversion is done, a lowercase character is perceived as an uppercase character. It follows that to send a lowercase "a," we must send a character whose code equals 97. Thus, we define S$(65) = CHR$(97). The sending array is defined so that when we type a given character, that character is actually sent to the mainframe. Conversely, the receiving array is designed so that when the mainframe sends a character, that character is correctly echoed on our microcomputer screen. (Table 1 is a comparison of the two sets of codes.)

The program itself includes few remarks, so detailed line-by-line comments are given in table 2.

Function Keys

The program is written so that the function keys serve the following special purposes:

- F1 display this function-key list
- F2 send text file to mainframe
- F3 print time since log-in
- F4 key repeat on-off
- F5 send log-in message
- F6 cursor (no) blink
- F7 caps on-off
- F8 change screen

If you have worked on terminals before, this list will be almost self-explanatory. Function key F1 prints the preceding list as a Help menu, in case you forget what the keys do. Using F2 is a bit more complicated and is explained in some detail under Sending Files.

On the mainframe I customarily use, there is a 60-minute time limit on the dial-up ports, so it is convenient to have easy access to the time since log-in. Because the VIC and 64 have built-in clocks, it was a simple matter to add this feature, which is accessed through the use of key F3. In this version of the program, the elapsed-time indicator ignores hours and resets to zero at 60 minutes. If

Listing 1 continued:

```
650  GET#5,ECHO$ : IF ECHO$ = "" THEN 600
651  PRINT ERASE$; R$(ASC(ECHO$));
652  IF ECHO$ = QUOTE$ THEN POKE 212,0
653  GOTO 650
655  ON CCODE% - 132 GOTO 370, 675, 700, 750, 800, 900, 950, 980
660  REM ************************************************************
665  REM *                  PRINT TIME SINCE LOGIN                   *
670  REM ************************************************************
675  PRINT
680  PRINT MID$(TIME$,3,2); " MINUTES SINCE LOGIN"
685  GOTO 600
695  REM ************************************************************
700  REM *                   SEND LOGIN MESSAGE                      *
704  REM ************************************************************
710  GET#5, CH$
715  LET TIME$ = "000000"
720  FOR K = 1 TO LEN(LGIN$)
725  PRINT#5, S$(ASC(MID$(LGIN$,K,1)));
730  NEXT
735  PRINT#5, CHR$(13)
740  GOTO 650
745  REM ************************************************************
750  REM *                      CAPS ON-OFF                          *
755  REM ************************************************************
760  LET CAP% = 32 - CAP%
765  FOR K = 65 TO 90
770  LET S$(K) = CHR$(K + CAP%)
775  NEXT
780  GOTO 600
795  REM ************************************************************
800  REM *                      SEND FILE                            *
805  REM ************************************************************
815  INPUT "NAME OF FILE"; NAME$
820  OPEN 1,1,0,NAME$
825  GET#1, CH$ : GET#1, CH$
830  GET#1, CH$ : IF CH$ = "" THEN 830
835  LET CCODE% = ASC(CH$)
840  IF CCODE% = 10 THEN CLOSE 1:GOTO 600
845  PRINT#5, S$(CCODE%);
850  FOR K = 1 TO 20:NEXT
855  GET#5,ECHO$: IF ECHO$ = "" THEN 870
860  PRINT R$(ASC(ECHO$));
865  IF ECHO$ = QUOTE$ THEN POKE 212,0
870  FOR K = 1 TO 20:NEXT
875  GOTO 830
895  REM ************************************************************
900  REM *                   KEY REPEAT ON-OFF                       *
905  REM ************************************************************
915  LET REPEAT% = 128 - REPEAT%
920  POKE 650,REPEAT%
925  GOTO 600
945  REM ************************************************************
950  REM *                  CURSOR BLINK ON-OFF                      *
955  REM ************************************************************
960  LET BLINKOFF = 1 - BLINKOFF
965  LET CURS^$ = DARK$
970  GOTO 600
975  REM ************************************************************
980  REM *                  CHANGE SCREEN COLOR                      *
985  REM ************************************************************
990  POKE 36879,8 :     REM  FOR 64, POKE 53281,8
995  PRINT CHR$(5)
1000 GOTO 370
```

you want to accommodate longer periods, then modify line 680 to include hours.

When the program first runs, only the spacebar and the backspace (Inst-Del) keys repeat automatically if held down. If you depress function key F4, all keys will repeat. Using this key again will return the program to the original mode.

Function key F5 is convenient when logging in. To use it, you'll first have to modify line 220 of the program, so that LGIN$ contains the appropriate log-in message. After this change has been made, hitting key F5 after receiving the carrier signal should log you in.

A standard feature of many terminals is a choice of either steady or blinking cursor. If you wish to have a steady cursor, it is only necessary to use key F6. Hitting the key for a second time returns you to a blinking cursor. Incidentally, when running the program, you will notice that I have used a cursor character that changes when the terminal program is running.

When you depress the Caps Lock key on your Commodore, it will affect not only letters but numerals and

COMPARE

The Benchmarks: Lomas Data Products vs. Compupro*

A benchmark comparison was made of the Lomas Data Products board set (LIGHTNING ONE, HAZITALL, LDP72 and RAM67) and a comparable COMPUPRO board set (CPU86/87 10MHz, INTERFACER-4, DISK1 and RAM21). *Both* CPUs were setup to run without waitstates during memory cycles. *Both* systems used double sided disk drives with 3 ms. step rates and used double density diskettes with 1024 byte sectors. The test consisted of assembling the source code for the example BIOS (BIOS.A86), distributed with standard CP/M-86**. The results should be self explanatory, *LOMAS DATA PRODUCTS offers superior performance.*

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RATIO TO 10 MHZ LIGHTNING ONE	1.00	1.17	.88
BOARD SET COST LIST PRICE AS TESTED	$2545.00	$3040.00	$3290.00
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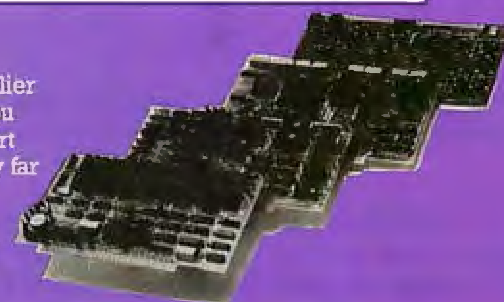

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Character	ASCII	Commodore	Character	ASCII	Commodore	Character	ASCII	Commodore
	32	32	A	65	193	a	97	65
!	33	33	B	66	194	b	98	66
"	34	34	C	67	195	c	99	67
#	35	35	D	68	196	d	100	68
$	36	36	E	69	197	e	101	69
%	37	37	F	70	198	f	102	70
&	38	38	G	71	199	g	103	71
'	39	39	H	72	200	h	104	72
(	40	40	I	73	201	i	105	73
)	41	41	J	74	202	j	106	74
*	42	42	K	75	203	k	107	75
+	43	43	L	76	204	l	108	76
,	44	44	M	77	205	m	109	77
-	45	45	N	78	206	n	110	78
.	46	46	O	79	207	o	111	79
/	47	47	P	80	208	p	112	80
0	48	48	Q	81	209	q	113	81
1	49	49	R	82	210	r	114	82
2	50	50	S	83	211	s	115	83
3	51	51	T	84	212	t	116	84
4	52	52	U	85	213	u	117	85
5	53	53	V	86	214	v	118	86
6	54	54	W	87	215	w	119	87
7	55	55	X	88	216	x	120	88
8	56	56	Y	89	217	y	121	89
9	57	57	Z	90	218	z	122	90
:	58	58	[	91	91	{	123	—
;	59	59	\	92	92	|	124	—
<	60	60	]	93	93	}	125	—
=	61	61	^	94	94	~	126	—
>	62	62	_	95	95			
?	63	63	`	96	96			
@	64	64						

Table 1: *A comparison of ASCII and Commodore character codes.*

special characters as well. This creates a problem when you wish to type progams in uppercase letters. When running the program, depressing function key F7 causes a shift to uppercase-only mode, and all letters will be sent as uppercase characters. However, numerals and special characters are not affected. To regain the ability to send lowercase characters, merely hit key F7 again.

As set up in the program, key F8 changes the screen to white characters on a black background, but you can modify the numbers in the POKE statement to get any color combination that is available.

Control keys are standard on a terminal, and on most computers serve the following purposes:

Control-C:	end of text
Control-S:	temporarily suspend transmission from mainframe
Control-Q:	resume transmission
Control-P:	Break key

The Commodore key functions as a control key and must be held down while being used.

If the English pound sign is sent, it will be interpreted as a backslash. The left arrow key sends an underscore and actually prints as an underscore on your screen. By changing the sending and receiving arrays, any ASCII character may be sent, but the characters echoed on your screen are limited to the standard set of Commodore characters. For more on this, see Modifying the Program.

Sending Files

Let's assume that you have a text file named "TEXT" stored on tape and you wish to send a copy to the mainframe. The exact procedure for sending files will vary slightly from computer to computer, but you should be able to adapt the basic method given here. The description that follows is for persons with cassette recorders. If you have a disk drive, you should be able to modify the procedure without too much difficulty. After logging in and starting a new file in your mainframe's editor, get into the input mode of the editor and then hit key F2. Your microcomputer will ask for the filename and then ask you to push the Play button on the cassette drive. As soon as the file is found, transmission will begin. After the file has been sent, it can be inspected or modified with the help of your large computer's editor.

If you want to send copies of the BASIC program, you'll first have to convert the program into a text file. To do this, first load the program into your Commodore. Then type

```
OPEN 1,1,2,"FILENAME":CMD 1:
LIST
```

This command opens a channel to the recorder, sends (via CMD 1) output to the recorder instead of the screen, and then lists the program currently held in memory. The cassette drive will stop and start a num-

Text continued on page 388

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Circle 171 on inquiry card.

Line	Comments
110	Set data-transmission rate to 300.
115	Set duplex to full, disable parity check, set bits to 7.
120	Open RS-232C channel as specified in lines 110 and 115.
130	Dimension sending (S$) and receiving (R$) arrays.
170–200	Define some of the constants used in the program. BACKSPACE$, ERASE$, DARK$, and CURSOR$ are used to control the cursor.
210	CAP% is used in conjunction with typing caps only.
220	This line should contain your actual log-in message.
225–340	Define sending and receiving arrays so that sent Commodore characters are converted to ASCII and vice versa. See table 1.
345	Enable lowercase character typing.
370	Clear the screen.
380–570	Print the function-key menu.
600	Print the cursor, CHR$(162).
605	If cursor blink is turned off, skip next three lines.
610–620	Controls blinking cursor display.
625	Get character from keyboard. If none typed, go to line 650 to look for character from mainframe.
630	Compute Commodore character code, CCODE%.
635	If character code is between 132 and 141, then a function key has been depressed; go to line 655 for further instructions.
640	Send typed character to mainframe.
650	Look for echo character returned from mainframe in full-duplex mode. If none received, then go back to look for character from keyboard.
651	Erase cursor and print character received from mainframe.
652	If a double quotation-mark character is received, then reset quote mode with proper POKE.
655	Determine which function key has been depressed and go to appropriate part of program for action.
680–685	Print time since log-in using built-in clock variable TIME$. Then return to main loop.
705–740	Send log-in message to mainframe.
705	Send carriage-return character to let mainframe know you are on line.
715	Set clock back to zero.
720–730	Using MID$ function and S$ array, send log-in message, one character at a time.
735	Send carriage-return character.
760–780	Caps only enable-disable.
760	CAP% will be changed from 0 to 32 or vice versa.
765–775	Change part of sending array corresponding to lowercase characters.
800–875	Send text file to mainframe.
815	Ask for filename.
820	Open cassette for reading. To read from disk, change this to OPEN 1,8,1,NAME$.
825	The first two characters in the text file are return characters and will be read and ignored.
830	This is the start of a loop. GET a character from the text file. If none is found, try again.
835	Compute the Commodore code of the character.
840	If the end-of-file character is found, then close the file and return to the main program.
845	Send proper character to the mainframe.
850	This is a delay loop. For some reason, the program wouldn't work right without this. The machine kept getting confused about which characters in the tape buffer had been read.
855	Look for echo from the mainframe.
860	Print the echo on the screen.
865	Reset the quote mode if a double quote received.
870	Delay loop—see explanation of line 850.
875	End of loop.
915	REPEAT% will change from 0 to 128 or vice versa.
920	POKE 128 will enable key repeat and POKE 0 will disable it.
960	BLINKOFF will change from 1 to 0 or vice versa.
965	This line makes sure the cursor is visible when blink is turned off.
990	Change screen to black.
995	Change characters to white.

Table 2: *Comments for listing 1.*

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PROMETHEUS

Text continued from page 384:

ber of times. (Programs stored as text files take up about twice as much tape as they do when stored as program files.) When the drive finally stops for the last time, some information will still be in the tape buffer. To get it out and to properly close the file, type

```
PRINT#1: CLOSE 1
```

The cassette will turn one final time and the program will be on tape, but as a text file, not as a program file. I recommend that you store any such text file at the beginning of a cassette, so that rewinding the tape is easy.

Modifying the Program

The program in listing 1 was written with two primary goals: efficiency and readability. Conserving memory space was a secondary consideration. If you have an unexpanded VIC, you'll have to "crunch" the program a bit. Take out all of the remark statements, use shorter variable names, leave out spaces, and, if necessary, take out the Help menu. With these changes you should be able to run the program.

To make the program usable with as many machines as possible, I had to make a few compromises. In particular, the limited memory of the VIC was kept in mind, and the 22-column VIC format was also a factor. One specific way in which this affected the program was in format of the Help menu. If you have a Commodore 64 you can spruce the menu up a bit.

If you want to add features to the program that are accessed through the function keys, you will have to give something up, of course. The (no) blink cursor option is an obvious candidate because it's a decision that most people want to make only once. If you opt for a (permanent) steady cursor, I recommend that you delete lines 605–620, which will improve program efficiency somewhat.

By using table 1, you can send ASCII characters not on the Commodore keyboard. Suppose, for example, that you wish to send the vertical-bar character, which has ASCII code 124. First, choose an "unused" key, preferably one with mnemonic value. In this case, a logical choice would be a Shift "–", which actually resembles the vertical-bar character. If you add the following line to your program, you will be able to send this character, and the echo you get back will be somewhat helpful.

```
325 S$(221) = CHR$(124) : R$(124)
  = CHR$(221)
```

The net effect of this line is that when you send a Shift "–", a vertical-bar character will be received by your mainframe, and when the mainframe echoes this character, a reasonable facsimile will be printed on your video display.

One program capability that you might want to add is the ability to communicate in half-duplex mode. This is relatively easy. First, change the value of the variable DUPLEX$ (line 115) to equal CHR$(176). Then, add the following line to the program:

```
626 PRINT CH$;
```

This line ensures that when a key is typed, it will appear on your screen. (Recall that in half-duplex, no echo is sent back from the mainframe.)

The data-transmission rate and the number of bits in the codes sent can be adjusted with the variable BAUD$. This variable appears in line 110 and is defined there as BAUD$ = CHR$(32 + 6). The 32 sets the number of bits in characters transmitted at 7. To change this to 8 bits, use a 0 instead. The 6 sets the data-transmission rate at 300. Using a 1, 2, 3, 4, 5, or 7 will change this to 50, 75, 110, 134.5, 150, or 600, respectively. More helpful information can be found in your VIC or Commodore 64 reference manual, and I'm sure there are a number of ways you could tailor this program for your own purposes.■

John P. Russo (16817 Cleveland Rd., Granger, IN 46530) is an associate professor of mathematics and computer science at Indiana University at South Bend, IN. While not using a Sage II or VIC-20, he enjoys woodworking, gardening, and playing handball.

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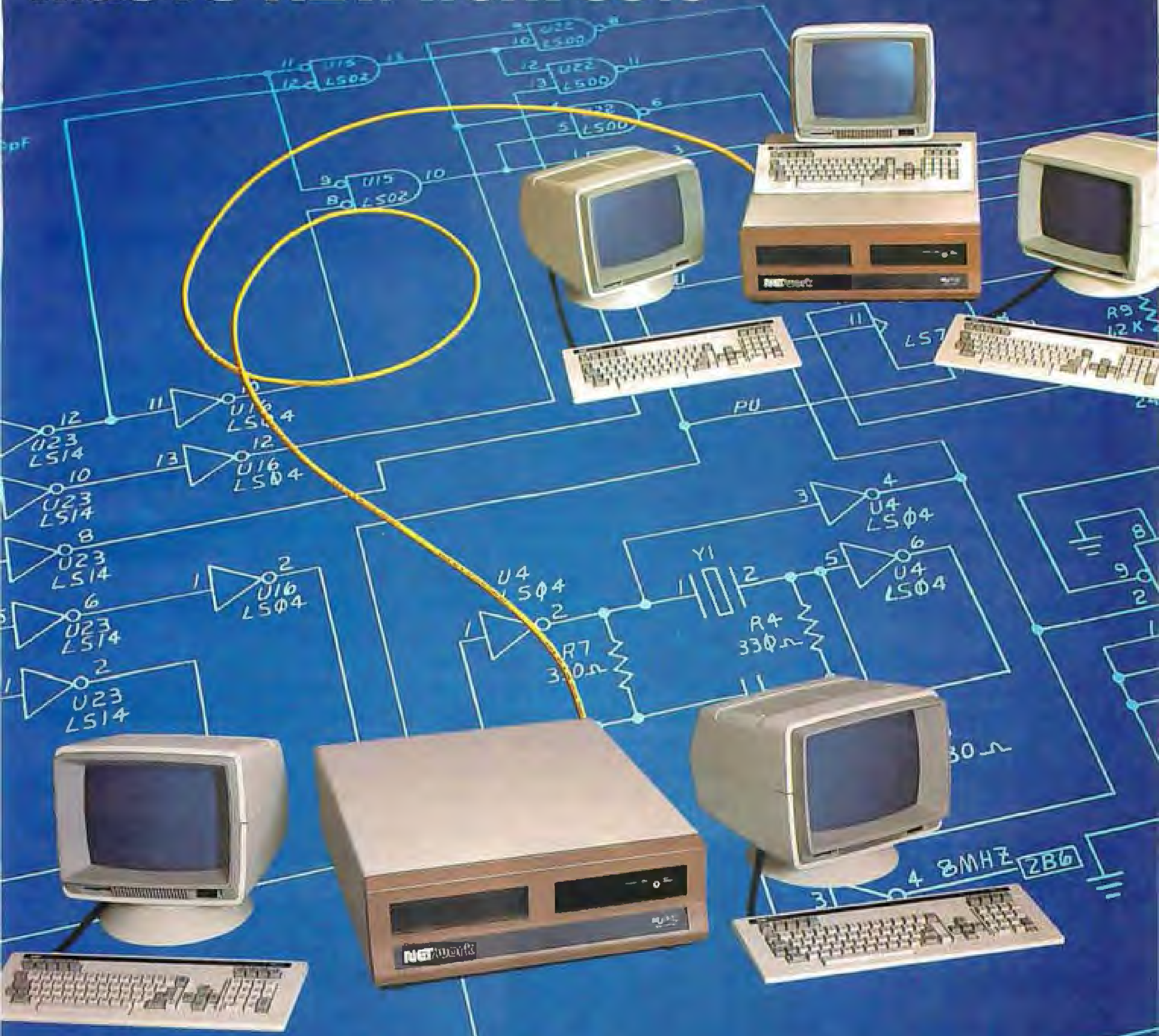

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A Keyboard Input Routine for IBM PC BASIC

Customize BASIC's INPUT statement for your application

Randy D. Peck
Pacific Micro Software Engineering

One of the more prominent shortcomings of BASIC, particularly for entry-intensive applications, is its lack of a formatted INPUT statement. When an INPUT statement is executed, the computer simply displays a prompt and waits for you to begin typing. You can type anything and everything—special characters, control codes, or the first three chapters of *War and Peace.* The BASIC INPUT statement offers no control over maximum field length or acceptable character set, and it does not differentiate between numeric and string variables until after the entry has been made.

It would be handy, in a number of applications, to have an INPUT statement that would accept only as many characters as it was programmed to accept—an INPUT that defined its input field with inverse blanks and could easily be adapted to accept only certain subsets of characters, such as integers, uppercase alphanumerics, or any other type. And it would be nice if the prompt were displayed in high-intensity characters, returning to normal intensity only after the input had been accepted.

The keyboard input described here has all these features and more. You need only change a few lines of your own BASIC programs to use it.

Operation

This subroutine (see listing 1) is meant to be used as a substitute for the BASIC INPUT statement and should be called with a GOSUB at the line where the INPUT statement would normally occur. Listing 2 illustrates a sample call.

The variables PROMPT$, ROW%, COL%, and FLDLEN% must be set in the program from which this subroutine is called. PROMPT$ is the text that should be displayed as the prompt. ROW% and COL% are integer variables representing the row and column of the display where the line will begin. The integer variable FLDLEN% should be set to the maximum number of characters allowed in the input field.

In setting these parameters, there are a couple of things to keep in mind. First, the input field begins at the print position immediately following the prompt; so, if you want spaces to appear between the prompt and the input, those spaces should be included as the last characters in the PROMPT$ string. Second, the routine requires that prompt and input be confined to a single line, so don't include any carriage returns in the PROMPT$ string. Also, if the number of characters in the prompt text and input field exceed the number of spaces remaining on the line (after the starting column position), the routine returns an error message and accepts no input.

In the subroutine itself, the first section of code does initialization. Some internal variables are set, and the prompt and a blank input field are displayed at the requested location on the screen. After that, the routine reads characters from the keyboard one at a time, checking whether they belong to a defined character set (the definition of such a set is discussed under Filters). Characters are displayed only if they are members of that set—invalid characters are ignored just as if the key had not been pressed.

Other checks prevent the user from entering too many characters or from trying to backspace out of the input field. Occurrence of either condition is signaled by a beep from the terminal (no displayed message). Note that once the input field is full, there are still two characters that can legally be entered: the backspace and the carriage return. Any other characters entered at this point will be ignored.

Text continued on page 396

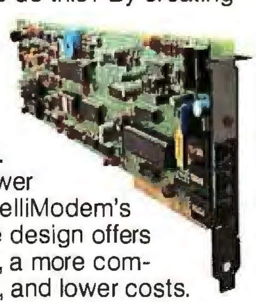
EVEN WHEN YOUR MODEM SENDS IT BY WAY OF THE OKEFENOKEE SWAMP.

When you send data by telephone through nasty environments like this, it can run into problems tougher than just alligators. Problems like impulse noise. Chatter from the switchgear. Static from the atmosphere or bad weather. Distortion due to crosstalk or just plain white noise.

To get your message through, your IBM PC or XT needs the advanced performance features of the PC:IntelliModem.™ It's got the best receive sensitivity available today—actually down below −50 dBm. So now you can achieve a high level of data transmission integrity. Even with bad connections.

Get patented modem technology.
The PC:IntelliModem is elegantly simple. Its patented design does it all on a single microprocessor chip, with just one crystal. Other modems take two, four or more μPs (and even more oscillators), and still accomplish less.

How do we do this? By creating architectural innovations in firmware, and by pushing the chip to its limit, close to 12 MHz. Since it uses fewer parts, the PC:IntelliModem's no-compromise design offers higher reliability, a more compact form factor, and lower costs.



This design elegance leads naturally to more elegant performance. Take line status detection, for example. The PC:IntelliModem's adaptive, decision-directed logic monitors line status more closely than other modems. Even at weak or degraded signal levels. So it can make connections with less chance of error, by detecting signals for dial tone, remote ringback, busy and voice—some of which other modems ignore.

Plan ahead with integrated voice and data.
For opening up a whole new world of integrated voice and data applications, there's nothing like the PC:IntelliModem. Literally. Its easy-to-use software package—PC:IntelliCom™—lets you switch repeatedly between talking or listening and sending or receiving data. All at the touch of a single function key. That means now both you and your computer can talk on the same line. Without having to hang up, re-dial or plug and unplug a lot of cables.

So if you're designing microcomputer datacomm products—or just looking for a PC/XT modem for yourself, check out the PC:IntelliModem at your local dealer. You'll get the message. And so will they. Or contact: Bizcomp, 532 Weddell Drive, Sunnyvale, CA 94089; 408/745-1616.

Bizcomp: A history of innovation.

1980	Invented first command-driven modem
1981	Introduced proprietary line-status monitoring
1983	Designed first single-μP 212A-compatible modem
1983	Introduced first integrated voice/data modem for IBM PC
1983	Granted patent on command-driven modem

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Integrated Voice/Data
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Status Reporting
- Line status detection (dial tone, busy, remote ringback, voice answer, modem answer, incoming call)
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PC:IntelliCom™ Software Included
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Receive Sensitivity: −50 dBm
Speeds: 110, 300, 1200 baud

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Listing 1: *Intended to be substituted for the BASIC INPUT statement, this subroutine displays your prompt in high-intensity characters. Immediately following the prompt is an input field defined by inverse blanks. It can be tailored to accept any type of input or subset of characters.*

```
1000 '*********************************************************************
1010 '*                                                                   *
1020 '*                A KEYBOARD INPUT ROUTINE FOR IBM PC BASIC          *
1030 '*                          by Randy D. Peck                         *
1040 '*                                                                   *
1050 '*   This subroutine is intended to be used as a substitute for the  *
1060 '*   IBM PC BASIC 'INPUT' statement.  It prints the prompt in high-  *
1070 '*   intensity, displays the input field in inverse, and accepts only *
1080 '*   the set of characters and number of characters defined by the   *
1090 '*   programmer.                                                     *
1100 '*                                                                   *
1110 '*   The following four variables must be set upon entry to the routine: *
1120 '*   PROMPT$ = String constant used to prompt for desired input      *
1130 '*   ROW% = Integer constant used as row for the prompt and input    *
1140 '*   COL% = Integer constant used as column the prompt will begin in  *
1150 '*   FLDLEN% = Integer constant defining maximum length of input field *
1160 '*                                                                   *
1170 '*   VARTXT$ = String variable returned from the routine             *
1180 '*                                                                   *
1190 '*********************************************************************
1200 REM  -------------------------------------------------------------------
1210 REM                     INITIALIZE THE DISPLAY AREA
1220 REM  -------------------------------------------------------------------
1230 VARTXT$=""                             'Initialize input buffer to null
1240 IF (COL%+LEN(PROMPT$)+FLDLEN%)>79) THEN PRINT "INPUT LINE TOO LONG.":RETURN
1250 FSTPOS%=COL%+LEN(PROMPT$)                   'First column of input text
1260 ENDPOS%=COL%+LEN(PROMPT$)+FLDLEN%    'One after last column of input text
1270 COLOR 15,0                   'Set character display to high-intensity mode
1280 LOCATE ROW%,COL%                      'Move cursor to desired coordinates
1290 PRINT PROMPT$;                        'Print the prompt in high-intensity
1300 COLOR 0,7            'Set character display to inverse mode (black on white)
1310 PRINT "_";            'Print inverse cursor at first input field position
1320 FOR I%=2 TO FLDLEN%
1330    PRINT " ";                    'Inverse blanks define rest of input field
1340 NEXT I%
1350 LOCATE ROW%,FSTPOS%       'Move cursor back to first column of input field
1360 REM  -------------------------------------------------------------------
1370 REM                        BEGINNING OF MAIN LOOP
1380 REM  -------------------------------------------------------------------
1390 CHAR$=""                     'Clear buffer used to hold current character
1400 WHILE CHAR$=""                          'Wait until a key has been pressed
1410    CHAR$=INKEY$                       'And assign it to the variable CHAR$
1420 WEND
1430 IF (POS(0)=ENDPOS%) AND (CHAR$<>CHR$(13)) AND (CHAR$<>CHR$(8)) THEN BEEP:
     GOTO 1370                                         'Check for field overflow
1440 REM  -------------------------------------------------------------------
1450 REM              THIS SECTION EXECUTES IF CHAR$ IS A BACKSPACE
1460 REM  -------------------------------------------------------------------
1470 IF (CHAR$<>CHR$(8)) THEN 1560   'If not a backspace then skip this section
1480 IF (POS(0)=FSTPOS%) THEN BEEP:GOTO 1370          'Can't backspace from here
1490 VARTXT$=LEFT$(VARTXT$,LEN(VARTXT$)-1)          'Remove backspaced character
1500 'The next three lines serve to backspace the cursor by one column:
1510 LOCATE ROW%,POS(0)-1
1520 IF (POS(0)<ENDPOS%-1) THEN PRINT "_ ";:LOCATE ROW%,POS(0)-2
1530 IF (POS(0)=ENDPOS%-1) THEN PRINT "_";:LOCATE ROW%,POS(0)-1
1540 GOTO 1370                                  'Go back for another character
1550 REM  -------------------------------------------------------------------
1560 REM  THIS SECTION EXECUTES FOR ALL OTHER CHARACTERS EXCEPT CARRIAGE RETURN
1570 REM  -------------------------------------------------------------------
1580 IF CHAR$=CHR$(13) THEN 1650              'If carriage return, then finish up
1590 REM  IF ANY 'FILTERS' ARE USED, THEY SHOULD BE INSERTED HERE.
1600 VARTXT$=VARTXT$+CHAR$      'Else add current character to input text buffer
1610 PRINT CHAR$;                                  'And echo it to the display
1620 IF (POS(0)<ENDPOS%) THEN PRINT "_";:LOCATE CSRLIN,POS(0)-1
     'If field not full, print a cursor character in the next field position
1630 GOTO 1370                                  'Go back for another character
1640 REM  -------------------------------------------------------------------
1650 REM        THIS SECTION EXECUTES WHEN THE CARRIAGE RETURN GETS PRESSED
1660 REM  -------------------------------------------------------------------
1670 IF (POS(0)<ENDPOS%) THEN PRINT" ";                  'Erase cursor character
1680 COLOR 7,0                       'Set character display back to normal mode
1690 LOCATE ROW%,COL%                    'Move cursor to first position of PROMPT$
1700 PRINT PROMPT$                    'And restore the prompt to normal intensity
1710                  'Use this line to convert VARTXT$ to the appropriate type
1720 RETURN                         'VARTXT$ now holds the new data in string form
```

THE BUFFER DID IT.

Who Stole The 1500 Letters From The Computer?

Let's just say you've got to send a letter to 1500 different people. Would you like to spend 22.5 hours* or 60 seconds of computer time?

With a garden-variety buffer, the computer has to mix, merge and send 1500 addresses and 1500 letters to the buffer. Trouble is, most buffers only store about 32 letters. So after 32 letters, the computer's down until the printer's done. Altogether, you're talking 22.5 hours.

In the case of our new (not to mention amazing) ShuffleBuffer, computer time is 60 seconds flat. Just give ShuffleBuffer one form letter and your address list, and it takes care of the mixing, the merging, and the printing. But that's not all ShuffleBuffer's stolen from the computer. Oh, no.

Who Changed and Rearranged The Facts?

Again, ShuffleBuffer's the culprit. You want to move paragraph #1 down where #3 is? Want to add a chart or picture? No problem. No mystery, either. Any buffer can give you FIFO, basic first-in, first-out printing. And some buffers offer By-Pass; the ability to interrupt long jobs for short ones. But only ShuffleBuffer has what we call Random Access Printing — the brains to move stored information around on its way to the printer. Something only a computer could do before. Comes in especially handy if you do lots of printing. Or lengthy manuscripts. Or voluminous green and white spread sheets. And by the way, ShuffleBuffer does store up to 128K of information and gives you a By-Pass mode, too.

And Who Spilled The Beans 239 Times?

Most buffers can't tell the printer to duplicate. If they can, they only offer a start/stop switch, which means you're the one who has to count to 239. Turn your back on your buffer, and your printer might shoot out a room full of copies. ShuffleBuffer, however, *does* control quantity. Tell it the amount, and it counts the copies. By itself.

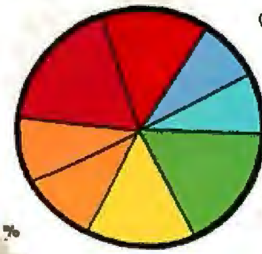
So, What's The Catch?

There isn't any. Sleuth around. You won't find another buffer that's as slick a character as this one. You also won't find one that's friendly with any parallel or serial computer/printer combination. This is the world's only universal buffer.

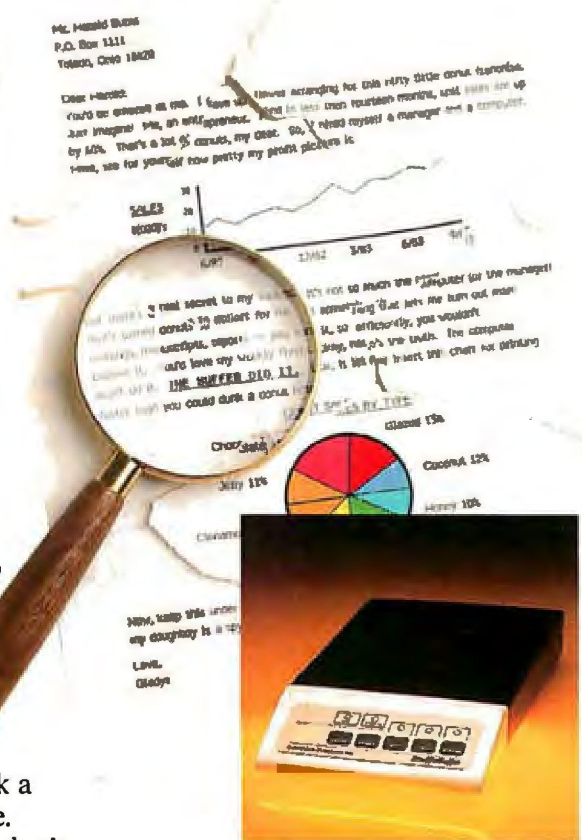
With a brain.

Who Wants You To Catch A ShuffleBuffer In Action?

You guessed it. We do. Just go to your local computer dealer and ask him to show you a ShuffleBuffer at work. Or, you can call us at (215) 667-1713, and we'll clue you in on all the facts directly.



* Based on an average 4000 character letter & 128K buffer.



ShuffleBuffer
The Buffer with a Brain

Interactive Structures Inc.
146 Montgomery Avenue
Bala Cynwyd, PA 19004

Listing 2: *This sample program segment shows how you might use the routine (two variations) to input a name and a social security number. Just set the text of the prompt, the location on the screen where you want the prompt to appear, and the length of the input field. Then, execute a GOSUB and set the results to your own variable name.*

```
100 '
110 '
120 '
130 COL%=1
140 REM GET NAME
150 PROMPT$="Enter your name: "
160 ROW%=5
170 FLDLEN%=15
180 GOSUB 1000  'Character input
190 NAME$=VARTXT$
200 REM GET SOCIAL SECURITY NUMBER
210 PROMPT$="Enter your social security number: "
220 ROW%=7
230 FLDLEN%=9
240 GOSUB 2000 'Whole number input
250 SSNUM=VARTXT
260 '
270 '
280 '
```

Text continued from page 392:

When the carriage return is finally pressed, the routine changes the prompt to normal intensity and executes a RETURN.

After returning from the subroutine, the string variable VARTXT$ holds the input. If the routine is set up to receive numbers, be sure to include a line such as:

```
1710  VARTXT = VAL(VARTXT$)
```

Immediately following the GOSUB, assign VARTXT$ (or VARTXT, if it is a number) to your own variable name. (Again, refer to the example in listing 2.)

Filters

To restrict the set of characters that may be entered during input, I have included a line in the subroutine (line 1590) that can be used to "filter" out the unwanted characters.

Because I did not include a specific filter in listing 1, the routine will accept any character the keyboard can deliver. To include a filter, either replace line 1590 with one of the following, or write your own to fit special requirements.

For positive whole numbers, use:

```
1590  IF (CHAR$<"0" OR CHAR$>"9") THEN
      GOTO 1370
```

For real numbers, use:

```
1590  IF (CHAR$<"0" OR CHAR$>"9")
      AND (CHAR$<>"-") AND (CHAR$<>".")
      THEN GOTO 1370
```

For uppercase alphanumerics and spaces, use:

```
1590  IF (CHAR$<"0" OR CHAR$>"9")
      AND (CHAR$<"A" OR CHAR$>"Z")
      AND (CHAR$<>" ") THEN GOTO 1370
```

Although this description implies that you should use a separate subroutine for each type of input you need to accept, it would be possible to use one subroutine for several types of input by coding for a fifth parameter (besides PROMPT$, ROW%, COL%, and FLDLEN%) to express input type. For example, an "input type" parameter value of "A" might tell the routine that you wanted to input an alphanumeric. You would then add a filter line for each type, using the form:

```
IF parameter value="letter" THEN text of filter
```

This would save memory if you had more than one type of input and could easily be added to the subroutine. I didn't write the routine this way because logical-strength, control-coupled modules (those that use a function-code argument to control program logic) are less than desirable from a design standpoint.

It's Not Perfect

The program falls short of being an ideal keyboard input routine. Its most serious limitation is its lack of control over the order in which characters must be entered.

For example, when you are entering numbers, the computer doesn't know that a minus sign can only appear in front of digits, or that the number of decimal points is limited to one. So when a real number is expected, the subroutine will accept input such as: 54.−2−−96.−. In this case, the value returned in VARTXT would be 54.

A Suggestion

To take full advantage of this subroutine, reuse it. Keep a copy of the routine on a disk, and the next time you write a program that needs keyboard input, merge it with this subroutine. You won't need to debug it—you did that the first time you used it.

Incidentally, I follow this practice with other routines. I keep dozens of subroutines for utilitarian purposes on separate disks.

Conclusion

I have presented a subroutine intended to replace BASIC's INPUT statement. By setting a few parameters and executing a GOSUB, your programs can become more user-friendly, more attractive, and ultimately more reliable than they were.■

Randy D. Peck (6000 Bay Shore Walk, Long Beach, CA 90803) holds a bachelor's degree in computer science and recently founded a company that writes custom software for small- to medium-sized businesses. He uses an IBM PC XT.

BYTE's User to User

Conducted by Jerry Pournelle

Needed: Spare Parts

Dear Jerry,

I read with considerable interest your description of your problems with one of the Tandon companies in "Buddy, Can You Spare a Door Latch?" (December 1983, page 59) because it raised familiar issues that have bothered me for some time. At present, there seems to be a serious limitation in the ability to get replacement parts for computer hardware, with the exception of integrated circuits. It appears to me that a significant subindustry could be developed that simply sells spare parts for currently available equipment.

This problem is not limited to Tandon. Last summer I worked for a small software company that needed to replace a stepping motor for its C. Itoh Prowriter printer. (The same printer is sold as the Apple Dot Matrix printer and, with a software revision, as the Apple Imagewriter. Though it is less popular than the Epson, it is more durable.) We were unable to find the motor anywhere and eventually had to take the printer to our dealer.

When you take something to your dealer, he doesn't generally replace a defective part, either. He replaces some subassembly. This is also the case in most mainframe repairs. It tends to be very costly, although in some cases it can save money, since subassembly prices are based on the average cost of repairing them. A subassembly such as a PC board that was completely destroyed by lightning would thus cost less to replace by this method than by locating and replacing all the defective parts.

Curiously, Appendix III of the Tandon *OEM Operating and Service Manual* gives a "recommended spare parts list"; where do they expect the end user to get those parts? The only clue is the note: "All components are standard commercial parts purchased to original equipment manufacturer's (OEM) specifications." That isn't telling much. The service manual, incidentally, is sold by Priority One; however, either they don't carry the parts or they aren't listed in the catalog. Your solution of buying a whole new spare drive seems kind of costly to me.

I was interested in particular by your experiences with Tandon. As a reader of *Electronics* magazine, I regularly see Tandon's large, impressive, multipage, heavy-paper advertisements. But it's true that the ads are aimed at engineers in large companies; your experience suggests that Tandon doesn't seem to feel end users are that important. That is unfortunate, since they are the authorities on their equipment, not the OEM or the dealer. Tandon is a well-known company in the electronics industry because it produces disk drives at a cost far below what others claim is the minimum feasible cost, and they are generally better drives. It is currently working on reducing the price of hard-disk drives and has announced a $500 hard-disk drive, with plans to reduce the cost even further. But the treatment you received from Tandon (which I must conclude I would also receive if I called the company) suggests that there is some need there for education in matters of public relations. It is not really an unreasonable request to expect to be able to get replacement parts. I wrote to Tandon several months ago regarding the use of its disk drives on models other than the IBM PC. I needed to know whether or not a given head-stepping rate was acceptable or whether it would damage the drives. I have received no reply.

As an independent software developer, your comments help me to understand the user's perspective on software; I always try to read all the User's Columns for that reason, and yours is by far the best. But I am always looking for new and better ways of doing things, and I will continue to watch Modula; I have a group of colleagues who are presently trying it out on a commercial project.

J. Eric Roskos
Nashville, TN 37212

The micro industry isn't going to be mature until there are multiple sources of spare parts at reasonable prices. That certainly hasn't happened yet.

Since my announcement in the December User's Column, Workman and Associates has had a positive flood of orders for Tandon Drive spare-parts kits. Alas, Tandon thinks four to six weeks is a reasonable delivery time for Workman's order; as I write this, Barry Workman still can't get door latches and the other parts. Tandon has a high minimum order, so no individual user can buy from the company either. We hope that by the time this is in

PGS introduces the no-compromise monitor to meet your no-compromise needs.

High resolution

Once you've invested in a first-rate computer, you don't want to compromise with a second-rate monitor. That's why PGS introduced the first no-compromise monitor, the Princeton HX-12. It set the price/performance standard for high resolution RGB color monitors.

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Now we're introducing the first no-compromise monitor in the super resolution class. It's our new SR-12: an RGB monitor that meets the most demanding expectations at a price that will surprise you.

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All three PGS monitors are engineered for no-compromise performance to provide you with a cleaner, sharper image than any other monitor in the same price class. The HX-12 and the SR-12 both feature uncompromising color convergence for crisp whites without color bleed. The MAX-12 offers impressive clarity in a monochrome monitor with easy-on-the-eyes amber phosphor.

And all three monitors come with a non-glare screen and a shielded cable that plugs directly into the IBM PC or XT.

The HX-12 has the highest resolution (690x240) and the finest dot pitch (.31mm) in its class. And yet its suggested retail price is comparable to many medium resolution monitors. The HX-12 brings no-compromise color to the PC and now, with the PGS RGB-80 board, to the Apple IIe as well. **Suggested retail price: $695.**

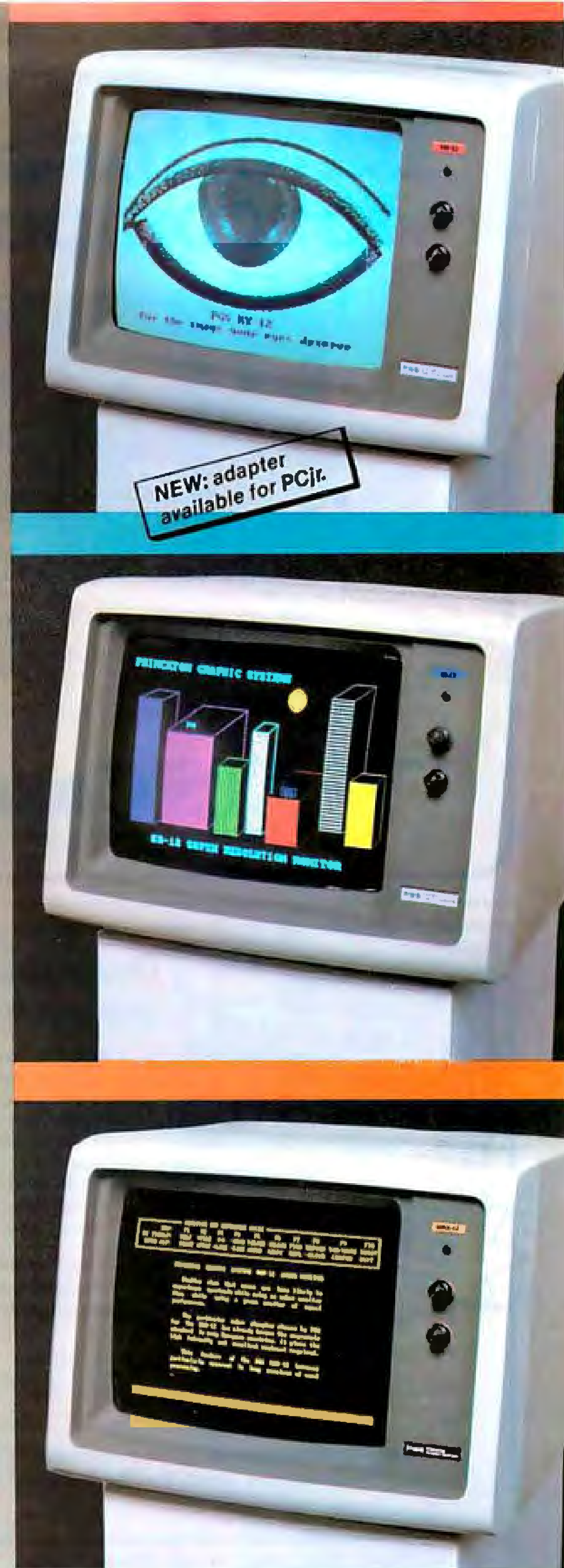
The new SR-12, in conjunction with the PGS high performance color graphics card, also features a .31mm dot pitch supporting 690 horizontal resolution. However, by increasing the horizontal scan rate to 27.5 KHz, the SR-12 can support 400 vertical resolution in non-interlaced mode. This results in a very high quality, flickerless image with the ability to generate graphics and text that is truly of monochrome quality. **Suggested retail price: $799.**

The new MAX-12 offers you easy-on-the-eyes amber with 720x350 resolution at a suggested retail price ($249) that is actually lower than the leading green-on-black competitor. And the MAX-12 runs off the IBM PC monochrome card—no special card is required.

Clarity of the Max 12 is enhanced by dynamic focusing circuitry which ensures sharpness not only in the center but also in the edges and corners. **Suggested retail price: $249.**

Whatever your needs, from word processing to super resolution graphics, there's now a no-compromise PGS monitor that sets the standard. Ask your dealer for a demonstration and let your eyes decide. Or call for more information and the name of your nearest dealer.

You can look to PGS for the image your eyes deserve.



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print, Workman will be able to ship spare-parts kits on the day the order is received.

I'm not entirely certain that Tandon's attitude about spare parts is reasonable, but there doesn't seem to be much we can do about it. I agree the company makes adequate equipment at good prices, but I pity anyone who has to deal with it directly. . . . **Jerry**

On Strange Equipment

Dear Jerry,

This letter is coming to you via an obsolete and nearly useless monster called a Sci-Pro 100A. I managed to get the use of this machine because the company I work for was going to be selling them (nobody bought any). However, there is no documentation for the operating system, called Sci-DOS, nor for its resident software, called Sci-Tran. The machine comes with a full program for a restaurant-management system and has lots of disks for that, but that is almost all it will do, aside from being a poor-grade TV-typewriter/printer. It doesn't even have cursor-control functions (or at least I haven't been able to find them). It will transmit a full screen (16 by 80) to the printer, but then it feeds a form at the end.

I'm writing to you in the hope that perhaps you might know (or know who would know) where I might get hold of the documentation for this beast. The manufacturers have gone out of business but were once to be found at: Sci-Pro Inc., 8505 East Orchard Rd. #106, Englewood, CO 80111.

Rumor has it that the Sci-Tran is an enhanced FORTRAN. You couldn't prove it by me. What little literature there is for the machine says it sold for about $20,000 retail, including a fairly nice 130-column printer. The microprocessor is supposed to be a custom 16-bit device, and it is a 3-chip system apparently built by Data General (at least the marking on the chips that I take to be the microprocessor lead me to that conclusion).

Gregory L. Shepherd
Salem, OR 97303

Alas, I know nothing of the machine. Perhaps one of the readers can help?

I'm far too dependent on microcomputers to take chances with obsolete equipment, and I can't really recommend it as a worthwhile practice. Years ago, MacLean and I used to play with older machines for fun, but I haven't time enough even for that now.

IF YOUR DATA'S WORTH REMEMBERING, IT'S WORTH PROTECTING.

POWERMAKER® MICRO UPS

A split-second blackout or a sudden voltage sag can shut down your small business computer, completely wiping out critical data. Inventories, payrolls, receivables — whatever is in the memory may be lost instantly.

Although this type of data is just as important to a small business as it is to a large corporation, blackout protection has always been far too costly for small business applications. But now there is the Powermaker Micro UPS, an inexpensive standby power source specifically designed for small business computers.

This new rechargeable power system provides up to 35 minutes of steady sine-wave power, enabling even the most sensitive small computers to ride through blackouts and voltage sags completely unaffected.

Why sine-wave power? Because square-wave power impairs the performance of many printers, viewing screens and timing circuits. A Powermaker Micro UPS produces a sine wave that exactly matches the waveshape of commercial power, ensuring compatibility with any computer system.

In addition to providing highly reliable blackout and brownout protection, a Powermaker system also protects against electrical noise, one of the major causes of computer errors and component malfunction. A Powermaker UPS is portable, completely automatic, maintenance free and plugs into any standard 120V outlet.

No matter how small your computer, your data is worth remembering. Protect it with an affordable Powermaker Micro UPS.

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BYTE's User to User

My advice would be to get something a bit more standard. I've seen the Osborne 1 for sale for as little as $595, complete with documentation. Add to that a Xerox Americare service policy and you've still paid very little for a machine that wouldn't have quite so many irritating quirks. . . . Jerry

Protection Schemes

Dear Jerry,

Emerging Technology Consultants Inc. of Boulder, Colorado, seems to have an interesting twist to copy-protect its new Offix software. While the company allows the loadable module to be copied, it requires that the distribution disk be inserted into a drive to begin program execution—possibly for the purpose of reading a cipher key. I find this unacceptable for reasons I stated in a letter to the company.

Emerging Technology also makes firm statements in the product instructions that DOS extensions are not supported in Offix. I was concerned that this was also a consequence of the copy-protection scheme. A telephone call to the company's office brought me the answer that no, this was only to free the company of responsibility for improperly designed extensions. I'm not sure that answers the question. However, I did not try the package, so I don't know if it would work with my AST disk-emulation software.

I use Emerging Technology's very excellent Wordix (text formatter) and Spellix (spelling checker) products, which are not copy-protected. However, I have returned Offix because in no place did the announcements indicate that it had imposed such restrictions. I'd appreciate your comments.

Mark Bigelow
Concord, CA 94518

The Offix package looks interesting from the advertisements (I don't think we've used any of Emerging Technology's software), but I certainly would never become dependent on anything that required an uncopyable original-distribution disk. There are just too many things that can happen to a disk.

The ad reads, in big, bold letters, "Execution of Offix without an original distribution disk in drive A or B may damage your computer." That would be more than enough to keep those programs out of my machines. Suppose the company made a mistake in its machine-damaging software?

It's surprising that Emerging Technology

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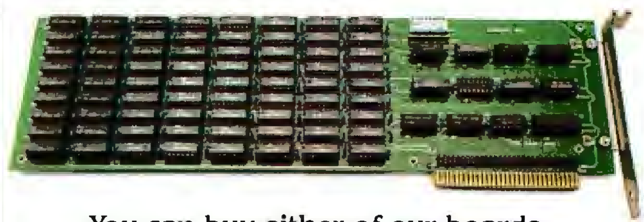

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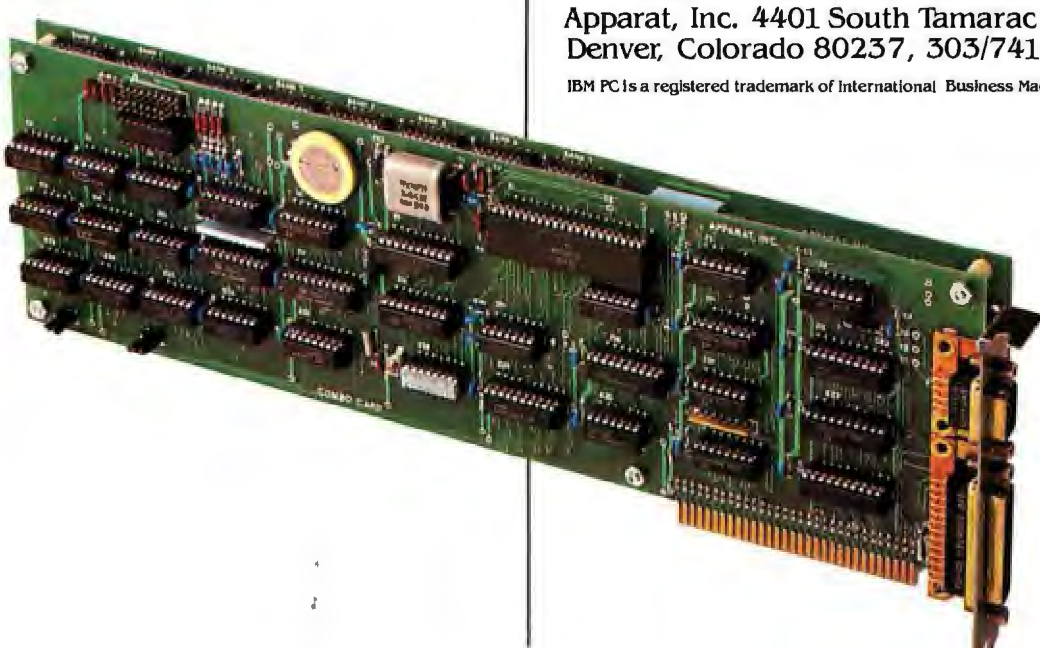

Apparat, Inc.

Circle 33 on inquiry card.

does this; its program cost of $99 invites customers to play fair, and I expect most would without the copy protection. In any event, I am not moved to trust the company's ability not to damage my machine, given that the company boasts that it can do it.

*Copy protection is futile anyway: any scheme you can devise can be defeated by a good systems hacker. Pirates aren't foiled by copy-protection schemes, but legitimate users often are. . . .***Jerry**

File-Check Function

Dear Jerry,

In BYTE's User to User (December 1983, page 499), in response to Alan Beagley's letter, you ask "I wonder how many other programs there are that allow illegal filenames?" Using dBASE II (2.4) and the MODIFY command, I created a file called TAB:SET.CMD that other dBASE command files could access, but it could not be accessed from Wordstar or CP/M because both "saw" TAB: as the drive. This was only a minor problem since dBASE could RENAME the file.

Ronny Richardson
Chamblee, GA 30341

It's really not hard to write a filename check function and, once that's done, to incorporate it into every new program. I wonder why more programmers don't do it?

*Thanks. . . .***Jerry**

More Power To You

Dear Jerry,

I am a hard-core programmer and love to program in assembly language. (I know it's weird, but even assembly language is easier when you enforce your own structure and comment it to death.) I say all of this to ask you if you have heard about any plans by AT&T to bring its 3B20D processor down to a single chip. It's a board-level product now. I think that AT&T has a great opportunity to produce a universal microprocessor since this device may store its microprograms in RAM (64K). Currently this is a 32-bit machine and thus expensive. There should be only a few problems making it into a 16/32 processor like the 68000.

I first saw information on the 3B20D in *The Bell System Technical Journal*, vol. 62, no. 1, January 1983. Pages 181 to 205 provide an overview of the whole system and a look at the processor. What we're talking about here (and what AT&T is talking about) is flexibility that microcomputer users have only dreamed of. Can you imagine running 68000, 16032, 8080-series, 6800-series, and even some IBM mainframe software on this machine? I think the Lisa software would be great on this machine if its primitives were implemented in microcode.

I can imagine all of this; I can also appreciate the complexity of the task. But I can also imagine AT&T competing with IBM by providing complete PC compatibility. AT&T can also provide service and reliability that IBM customers have come to expect. I would appreciate any information on the subject.

Leonard Timmons
Atlanta, GA 30342

Sounds interesting!

We all expect AT&T to come strongly into the micro market; it should provide an effective counterweight to IBM.

*Of course IBM and AT&T are pretty big spheres; even jammed closely together that leaves a lot of room for smaller fish in the interstices! What with the 16032 coming, and the falling prices of memory, it's clear that we'll have some really powerful machines to work with; it's important, though, that we don't let the micro community get split into dozens of incompatible little fiefdoms. . . .***Jerry**

Scientists: FORTRAN vs. Modula-2

Dear Jerry,

Though your answer to Mark Finger's letter (BYTE's User to User, December 1983, page 499) may have been appropriate for most users, physics and astronomy students simply have to learn FORTRAN. So much exists in FORTRAN that it seems unlikely that scientists will change to Pascal, Modula-2, or whatever. We need FORTRAN on microcomputers so that students can work up programs and eventually transfer them to other computers or else be able to write similar FORTRAN programs or patches on mainframes.

It often seems that scientists have been forgotten by the makers of modern small computers; we are undoubtedly too small a market.

Jay M. Pasachoff
Hopkins Observatory
Williams College
Williamstown, MA 01267

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and slowly but surely it's being improved. Indeed, some versions of FORTRAN for the IBM PC and other 8086 machines have library routines for using the power of the 8087 math chip, which gives you more of what you want to use FORTRAN for.

*I remain unrepentant: I believe that any program you can write in FORTRAN is better written in Modula-2, unless you simply want quick and dirty answers to specific problems and have no intention of ever running the program again. In those cases, BASIC works quite well, as does APL. . . .***Jerry**

An Expressive Exclamation

Dear Jerry,

First of all, I've been hearing rumors about a new single-chip 300/1200 bit-per-second (bps) modem that's supposed to be coming on the market around the first of the year. It's supposed to sell for something like $50, possibly less. Do you have any information on it? We've seen major price breakthroughs on disk drives, printers, and computers. Meanwhile, modems are still expensive, especially the 1200-bps units. Is the time ripe for some action in the marketplace with this product?

Secondly, in BYTE's User to User for December, you may have set an Olympic record by using the word "alas" at least nine times. There may be more; I lost count. Do you know of a good microcomputer version of *Roget's Thesaurus*? I'll help buy it for you since, except for that one minor fault, your column is both readable and useful.

Lewis M. Phelps
San Francisco, CA 94118

Unfortunately, I know of no 300/1200 bps modem at anything like that price. I wish I did.

*Ouch. . . .***Jerry**

Hacking Redefined

Dear Jerry,

Perhaps there is no universal agreement on what is meant by the word "hacker," but most dictionaries of the English language are quite colorful in their definition of the word "hack."

Moreover, while there may be times when what one wants is a literary hack, are you proud of your potboilers? Although language is dynamic and extensible, it should not be traumatized by con-

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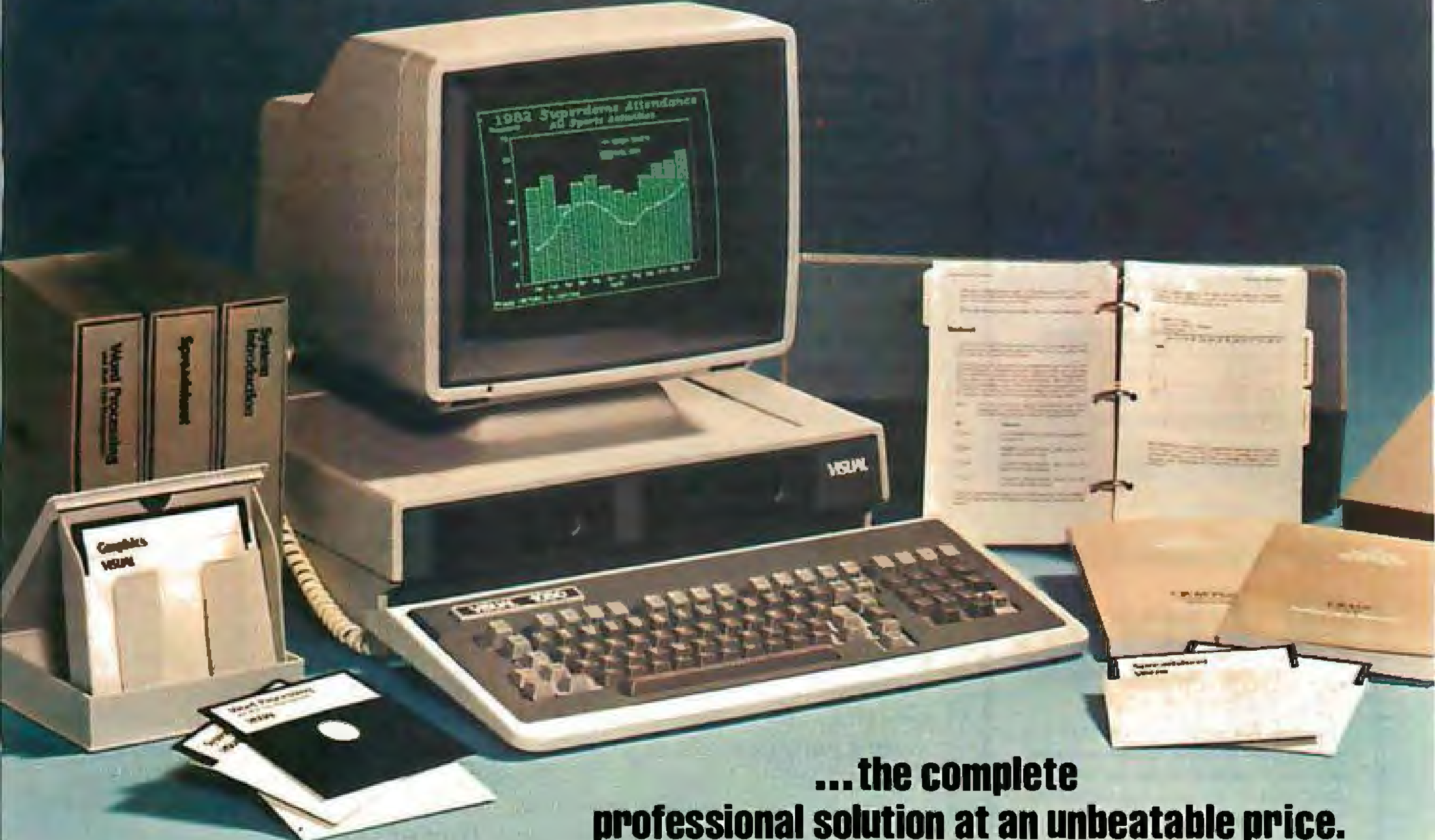

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Optional Winchester	YES	YES	YES	YES
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tradiction. Whenever the words Apple, Hero, Rainbow, Winchester, Volition, Reality, and Prometheus appear in a distinguished publication (i.e., *Random House Dictionary of the English Language*) in their usurped sense, I will deal with them as they are defined. Until there is universal agreement on a complimentary definition of "hack," I will continue to construe it in its derogatory sense.

Thank you for your very informative BYTE columns, and for the ones that are amusing as well.

Ron Dotson
Glendale, CA 91208

The origin of "hacker" as applied to computer people is obscure. I'm told that it comes from an older expression that implies something worked crudely, as in making furniture with an ax.

However, at MIT and a number of other institutions it is a mark of pride to be a "hacker," since it implies that one knows how to get inside the operating system and, in general, do fancy things with the machines. Also, it has become a pretty standard verb, as in "hacking your BIOS."

Since a lot of programmers are proud to call themselves hackers, your determination to use the word in the old way could result in communicating something not intended.... **Jerry**

Eight Bits are OK

Dear Jerry,

Analyzing microcomputer systems, I found that there is a huge class of 8-bit applications and algorithms: word processing, compilers, interpreters, in fact everything that has to analyze, manipulate, or generate text characters. It is not surprising to find that 8-bit microprocessors are the most effective for these tasks. For example, Wordstar for CP/M requires only half the memory of the IBM PC version.

If you use the memory that you saved using an 8-bit microprocessor instead of a 16-bit one as a silicon disk, you actually get more throughput for the same money with an 8-bit system.

Some might argue that the 16-bit machines can address more memory. For most home applications, however, I regard this as a burden and not a feature. Because programs suddenly have to work with 24-bit addresses, they become more complex, bulkier, and sometimes slower.

If a 16-bit machine is really faster than an 8-bit one, so what? Who cares waiting 10 milliseconds more or less for an editor command? And what's so great about a 16-bit compiler that saves you 20 seconds processor time if the disk input/output took 5 minutes?

When it comes to number crunching, the 16-bit machines are of course superior to their 8-bit brothers. But 32-bit machines would be even more powerful. And how about 64 bits or ...? There are almost no applications where a 16-bit microprocessor would be more efficient than a 32-bit machine. So why use a 16-bit if you can have 32 bits or more? As a result, 16-bit machines will soon be just a memory of an evolutionary step in computer history.

The 8-bit machines, however, will stay for a long time to come. I see a future for them in the home and personal computer market where most applications are text oriented: videotex, electronic mail, electronic banking, and electronic bulletin boards, to name a few.

There is a computer euphoria these days and many people just buy the latest and newest stuff, not analyzing their needs. Once the euphoria has settled, many users will realize that an 8-bit system can do their job cheaper.

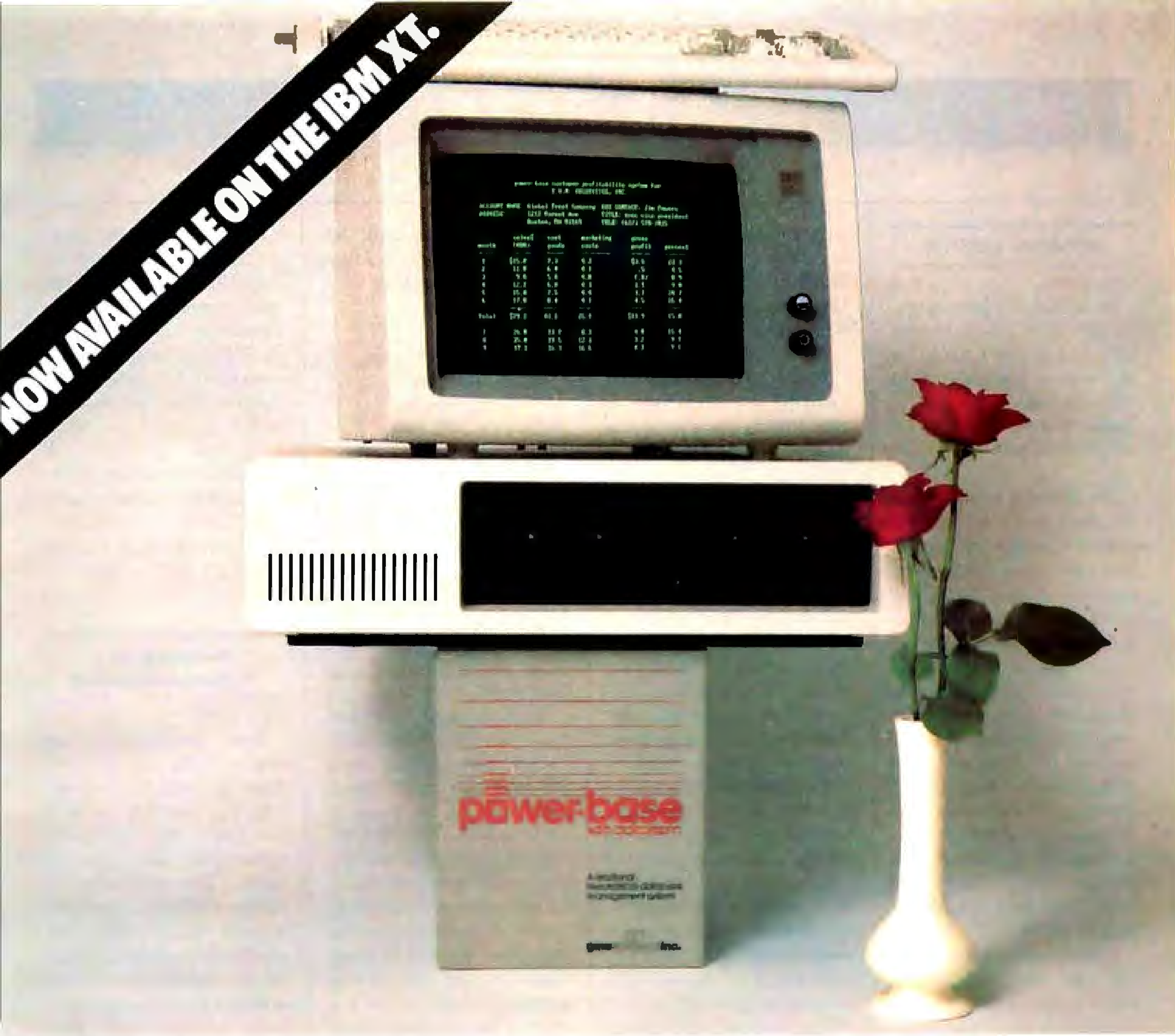
Hanns Proenen
Cologne, West Germany

I, too, believe the 8-bit machines will be with us for quite a while. However, 16-bit systems do have considerable advantages for graphics; if you're doing spreadsheets and such, the faster number crunching becomes significant; and good on-line help and self-documentation takes lots of memory.

Also, consider the question of languages. The 16-bit machines are, or can be, a great deal faster for higher-level-language programmers to work with. Some of the better languages, such as Modula-2, don't exist on 8-bit machines; thus, some of the newest and best software will be awhile getting down to them. . . . **Jerry**■

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

Jerry Pournelle welcomes readers' comments and opinions. Send a self-addressed envelope to Jerry Pournelle, c/o BYTE Publications, POB 372, Hancock, NH 03449. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply.



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Ask BYTE

Conducted by Steve Ciarcia

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Dear Steve,

I'm looking for information on an IMSAI computer system and where I might be able to purchase one. Thanks for your help.

Danté Mahoney
Mt. Laurel, NJ

The IMSAI computer system was one of the first S-100 bus systems manufactured. It had a front panel from which bootstrap programs could be loaded and which presented the status of the system to the operator. The old IMSAI system is no longer manufactured, but many of these systems exist and are sometimes resold by individuals. Advertisements for IMSAI equipment can be found in buyer guides such as Computer Shopper *under the heading S-100 Equipment. Subscriptions can be obtained from Computer Shopper, POB F, 407 South Washington Ave., Titusville, FL 32796.*

A new improved IMSAI 8080 has been introduced by the Fischer-Freitas Corporation. A catalog of the new IMSAI product line can be obtained from IMSAI Computer Division, Fischer-Freitas Corp., 910 81st Ave., Bldg. 14, Oakland, CA 94621.... **Steve**

VIC-20/Apple Disk Drives

Dear Steve,

I have an odd combination for you! Do you know if there is any way that I can make my VIC-20 compatible with Apple III disk drives? I don't believe there is any product on the market that will connect these two. Could you provide me with the information to build the necessary circuitry or to get in touch with someone who could help? If possible, I would like to do this for less than $100. Thanks for your time.

Lee Brewer
Greenville, SC

Short of building a disk-drive controller and interfacing it to your VIC-20, there is no easy way to achieve compatibility with Apple III disk drives. The disk drives designed for the VIC-20 are called intelligent *drives because they contain their own 6502 microprocessors. Some of the computer overhead that is expended in initializing a disk and reading and writing files is handled by the drive circuitry. The Apple III uses a different type of disk-drive controller, and much of the drive operation is software controlled.*

A suitable controller could be built, but the price would depend on your supply of components. It could easily cost $100 or more. You would then have to write your own disk operating system to run this drive, and it would be incompatible with any disk programs commercially available for your VIC-20.

There is always a reluctance to buy an accessory that costs more than the base unit, as is the case with the VIC-20 and its disk drive, but, in this instance, it is the wiser choice.... **Steve**

Mail-Order Service Training

Dear Steve,

Is there a course in computer servicing that you can recommend? I live out in the backwoods and would like to learn more about doing my own servicing, preferably via a correspondence course. Any help you could provide would be appreciated.

Terence Buie
Porthill, ID

Several correspondence courses are available that deal with computer servicing. You can obtain free catalogs for these courses by writing to

NRI Schools
McGraw-Hill Continuing Education Center
3939 Wisconsin Ave.
Washington, DC 20016

National Technical Schools
4000 South Figueroa St.
Los Angeles, CA 90037.... **Steve**

MC68000 and the p-System

Dear Steve,

I'm working on an implementation of the adaptable p-System from Softech using my own Z80-based hardware, and I'd like to get it running with the MC68000. Maybe you can help me. Do you know of any manufacturers that supply microcomputers or boards that use the VME bus? Do any of these manufacturers offer the p-System as an option? Do you know if there are any implementations of the p-System in a multiuser environment (as a task under Unix) or using local networks?

Lipkunsky Nahum
Tel Aviv, Israel

Signetics Corporation manufactures four board-level modules for the VME bus and a VME bus card cage. The boards include an MC68000 processor with optional memory-management unit (MMU), a 256K-byte memory board, a disk controller, and a system controller board. The processor board can be used in multiuser, multitasking systems and can respond to any of the seven priority interrupts from the VME bus. For more information, write to Signetics Corporation, 811 East Arques Ave., Sunnyvale, CA 94086.

Empirical Research Group Inc. is developing products for the VME bus using 68000 and 16032 processors. It may have information on a p-System for the VME bus. You can obtain information on ERG products from Empirical Research Group Inc., POB 1176, Milton, WA 98354.

You should also be able to obtain more information on the newest versions of the p-System from Softech Microsystems, 16885 West Bernardo Dr., San Diego, CA 92127.... **Steve**

Building and Troubleshooting

Dear Steve,

First, I want to tell you how much I enjoy your projects; then I'd like to ask your advice on a couple of my projects. I'm trying to add an infrared (IR) sensor to my robot. The transmitter is simply a 555 pulse generator driving an IR LED; the receiver is a phototransistor/741 op amp/567 tone decoder combination. I can't seem to make the system work. How can I verify that the IR beam is being received?.

My second project involves communications. I have a chart of frequencies that are assigned to numbers for signaling specific units. I'd like to be able to enter a given number via a simple contact-closure keypad, decode this through a keyboard decoder, and have the output drive seven-segment displays that indicate the frequency assigned to that number. Any suggestions?

Also, can you recommend some necessary test equipment and perhaps a good book on using test equipment and doing troubleshooting?

Ray Poli
Flint, MI

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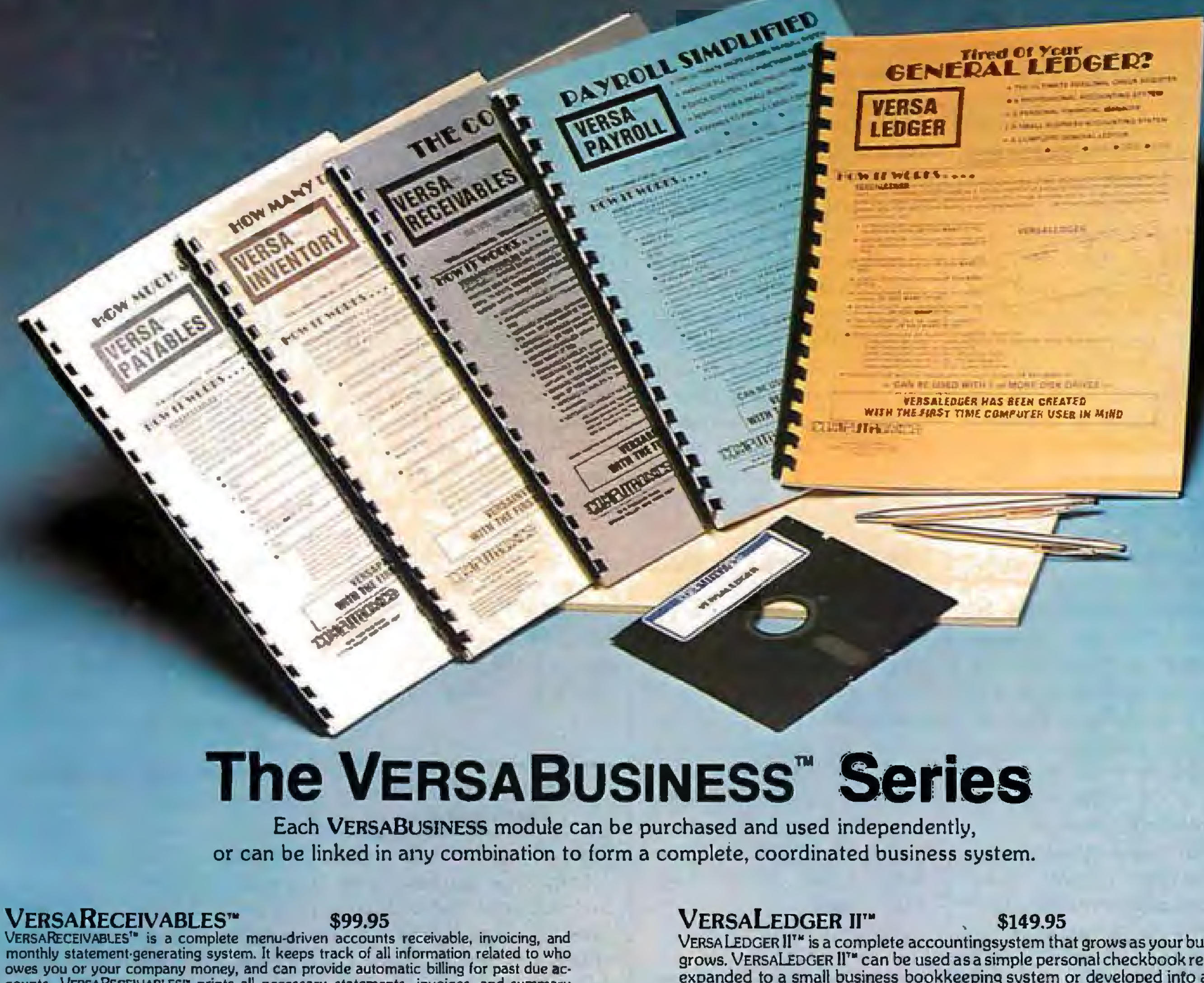

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The circuits you described for your IR transmitter and receiver sound like they should do the job if they were working properly. Troubleshooting circuits of this type is not difficult if you have an oscilloscope available. The classical approach is to start looking for the proper waveforms at their sources (in this case, the 555 pulse generator) and continue through the stages of circuitry until the waveform is lost. The problem can then be isolated to a few components in the stage where the waveform was lost.

If everything looks good in the transmitter, then place the receiver phototransistor close to the transmitter LED and start looking for a waveform with the same frequency as in the receiver. Don't try to measure a waveform on the input pins of the 741 (pins 2 or 3) because the operation of the 741 will try to force these two pins to the same potential (usually virtual ground in most applications).

Problems can arise from the design of the circuits and the environment in which they are used. First, if the device is to be used in a room with high ambient light, you may want to use a PIN diode in the receiver in place of the phototransistor to reduce the effect of ambient light. Second, recheck the calculations for the center frequency of the 567 tone decoder to make sure it matches the frequency of the waveform at the 555. Third, if no signal is detected at the phototransistor, you may need to get a higher-powered LED or place several LEDs in series to obtain a larger IR signal.

An excellent article on this subject appeared in the November 1983 Computers & Electronics *(see The Electronics Scientist column by Forrest M. Mims, page 90).*

To do an effective job troubleshooting digital circuits, you should have a volt-ohm meter (VOM), an oscilloscope, and a digital-logic probe. Depending on the circuit being analyzed, some or all of this equipment may be needed. Several books on troubleshooting are available. One is Troubleshooting Microprocessors & Digital Logic *by Robert L. Goodman. It can be obtained from Electronics Book Club, Blue Ridge Summit, PA 17214.*

Your question about displaying frequencies using a single contact-closure keypad will require the construction or purchase of a small, dedicated computer with a seven-segment readout. For example, a small pocket computer like the Radio Shack PC-4 could be programmed in BASIC to display a frequency on its one-line liquid-crystal display. If you construct your own dedicated computer, a microprocessor could be used to scan the keyboard and jump to a software routine stored in EPROM. The routine would point to the proper frequency (depending on the key that was depressed) already stored in the EPROM and send the proper seven-segment code, 1 byte at a time, to a multiplexed seven-segment display. The multiplexed display can be controlled by a UDN-2981A segment driver and a 75492 or 74145 digit driver. The construction of a small 8085-based computer of this type was described in the September 1980 Microcomputing *(see "Build Your Own 8085A-Based Micro," page 62)....* **Steve**

512K for the S-100

Dear Steve,

Is there a source for a 512K-byte dynamic RAM card with bit parity for the S-100 bus? If not, what would be the best way to go about building one for use with my Z-100? Thank you for your help.

Marshall F. Peterson
Covina, CA

The largest dynamic RAM boards that I have seen on the commercial market for the S-100 bus are 256K bytes. These boards are available through several advertisers in BYTE, such as Priority One Electronics, Jade Computer Products, and California Digital. These boards are presently using 4164 dynamic RAM chips, but with the 256K-bit chips waiting in the wings it won't be long before these boards take another step upward in size. If you are looking for an M-Drive, you can get one with 512K bytes of memory that is IEEE-696 compatible from Priority One.

Constructing a dynamic RAM board with 512K bytes can be tricky because many times these large memory chips do not lend themselves very well to wire-wrapping techniques. It can, however, be accomplished, and an excellent two-part article on the subject appeared in the March and April 1982 issues of BYTE (see "Build This Memory," parts 1 and 2). In this case, the author, Cameron Spitzer, used 4116 devices to build a 64K-byte S-100 board but discusses the use of 4164 devices to expand the board to 256K bytes. These same principles could be used to build a 512K-byte board if care is exercised.... **Steve**

Data Conversion/ Transmission

Dear Steve,

Some time ago I acquired an instrument that reads colors in the visible-light spectrum and displays them in terms of red, blue, and green by providing a 3-digit readout for each color. In addition to the 9 digits that represent the colors, a 6-digit counter keeps track of the number of measurements taken, providing a total display of 15 digits. Each digit is driven separately by a 7447 driver/decoder and latched with a 7475 latch. The instrument works fine in every respect, but there is no interfacing provision for any type of external computer or printer. I've been able to extract the BCD (binary-coded decimal) output for each digit, and now I need an interface, either parallel or RS-232C. I would appreciate your advice.

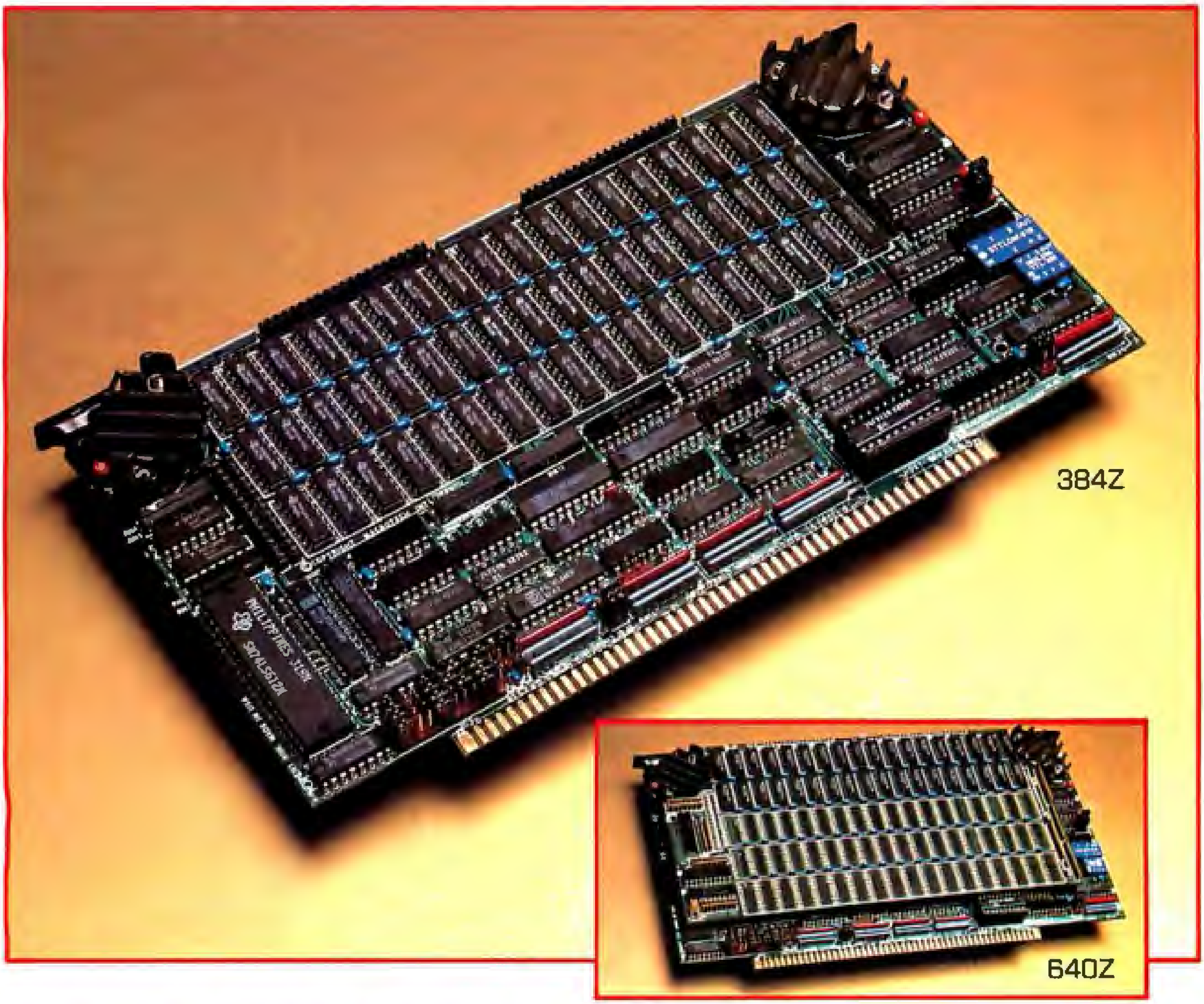
Robert Cvetkovic
Lorain, OH

Extracting data from one device and sending it to another is always a challenging project, and usually there are several ways to attack the problem. With the information you provided about the instrument, the problem seems to be in multiplexing the BCD data from the 7475 latches onto a common 4-bit bus. Once this is accomplished, it is a simple matter to convert the BCD data to ASCII data and transmit the information serially with a UART (universal asynchronous receiver/transmitter). Figure 1 shows one method for doing this that might work.

The 74LS150 data selectors will transmit the information present on one of the input lines (E1 to E15) to the output of the selector (W). The line selected is determined by the binary value present at the A, B, C, and D inputs. Because 4 bits are to be selected for each BCD digit, four 74LS150s are used. A 74LS163 4-bit binary counter is used to determine which digit will be selected. The outputs of the four data selectors now form the BCD value of the selected digit. This value could now be transmitted by the UART as BCD data, but one more chip will convert the data to binary information. This is accomplished with the 74LS184 BCD-to-binary converter, and the binary output now forms the lower 4 bits of the byte to be transmitted. The upper 4 bits of the transmitted byte are hard-wired at the UART to convert the data to ASCII representation.

Once the display is latched, a pulse applied to the TBRL (transmit buffer register load) input of the UART will latch the ASCII code for the first digit into the UART transmit buffer. The UART will now transmit the first byte through the serial output line (TRO) and send a pulse from the TBRE (transmit

Text continued on page 417



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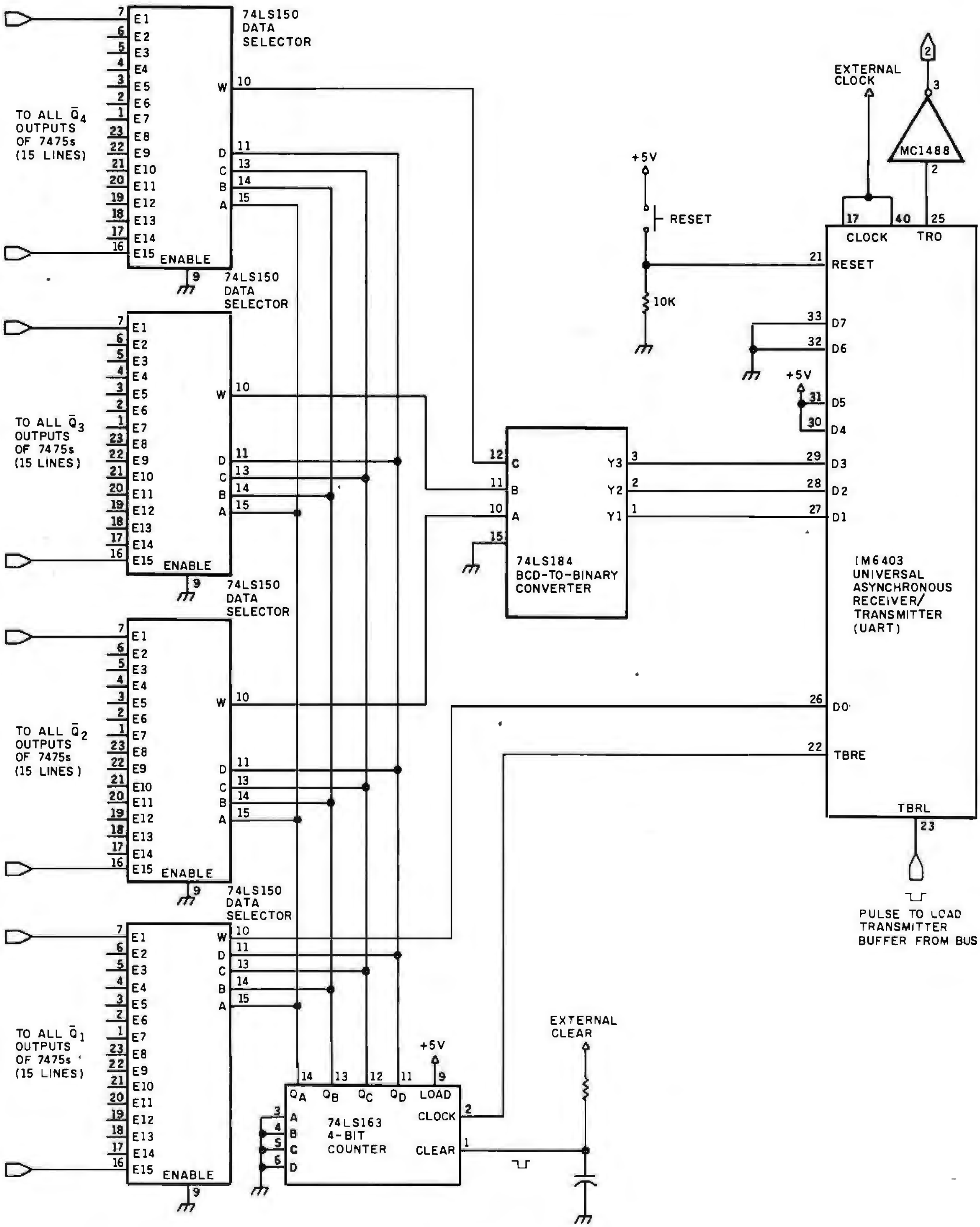

Figure 1: *A method to convert BCD data to ASCII data.*

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Text continued from page 412:

buffer register empty) line to the 4-bit counter. This pulse will increment the counter, which will select the next BCD digit to process and send through the UART. The next pulse applied to TBRL will now send the second digit. This procedure is repeated until all 15 digits are sent.

The TBRL pulse can be derived using a simple push-button switch with a debounce circuit, or it can be sent as a handshaking signal from the receiving device back through the RS-232C connector.

The circuit does not show the power and ground pin connections and does not show the connections for unused pins on the various ICs. These connections can be found in the specification sheets for the individual ICs. . . .

Steve

Light Pen for the 64

Dear Steve,

I would like to build a light pen for my Commodore 64. It has to be compatible with the 64's VIC II (6567) video-interface chip, which means that the pen must cause a negative transition on pin 9 (active low). When the VIC II detects a negative-going edge on this pin, the current screen raster location is latched into a pair of memory registers. If the light-sensing device is too sensitive, some sort of switch will be required to prevent accidental triggers. The light pen will be connected to the VIC II via a 9-pin D-type connector. Pin 6 is the output, pin 7 is +5 V, and pin 8 is ground. I'd certainly appreciate any help that you could provide.

Philip Escobar
Salinas, CA

Figure 2 shows a simple method of constructing a light-detecting device. The FPT-100 is a sensitive phototransistor that can be purchased at your local Radio Shack store. When the phototransistor is exposed to light, the voltage at the junction of the transistor and the resistor is reduced from 5 V to approximately 0 V. While I haven't tried it, it is possible that the phototransistor and the resistor alone will work in your application when mounted in a suitable enclosure. The 74C14 hex Schmitt trigger shown in the schematic will offer the circuit about 1 V of noise margin due to the hysteresis characteristics of the chip. This will make the circuit less sensitive to spurious noise effects. The Draw switch is a normally open push-button-type switch that activates the light device when it is depressed. When the switch is open (not depressed), the circuit will remain inactive with the output maintained at +5 V.

The sensitivity of the circuit can be adjusted by varying the resistor value. The higher the resistor value, the more sensitive the circuit will become. Don't forget that sensitivity can also be

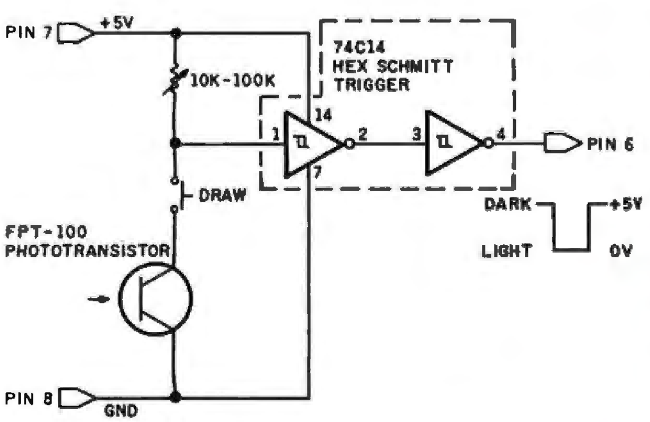

Figure 2: *Light-pen diagram for the Commodore 64.*

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affected by the brightness of the screen display.

Several articles have been written on interfacing light pens that may be helpful:

Pytlik, William F. "PET Pen." Microcomputing, *July 1980, page 84.*
Holder, Wayne. "Constructing a Light Pen." 80 Microcomputing, *April 1980, page 38.*
Mims, Forrest M. "Experimenting with a Light Pen." Popular Electronics, *December 1980, page 80.*
Lilja, David J. "Build a Simple Light Pen for the Apple II." BYTE, *June 1983, page 395. . . .* **Steve**

Disk-Format Compatibility

Dear Steve,

I am looking for a portable computer that can read, format, and write a variety of CP/M disk formats, but so far I have not found one that can read Apple CP/M disks. Do you know of any software that can be used on a Z80 computer to accomplish this task? Why isn't at least one widely used disk format standard for 5¼-inch disks? Thanks for your help. I look forward to reading Ask BYTE and your Circuit Cellar articles every month.

Bob Midden
Baltimore, MD

Compatibility among disk formats for 5¼-inch disks is virtually nonexistent. Even if the format for two disks appears to be the same, it is not likely that they can be read by different machines. The only real method of obtaining disk compatibility among different systems is to use an 8-inch single-sided single-density disk drive that uses the IBM 3740 format. This format allows disks written under CP/M to be read by other systems using CP/M.

Committees are being set up to address this problem in the future, but knowing standards committees, it may be years before an accepted 5¼-inch standard is adopted.

However, all is not yet lost. Several software houses are beginning to write software that reconfigures the software drivers of several CP/M computers so that they can read disks formatted on other 5¼-inch CP/M systems. For example, Port-A-Soft is selling software that allows Morrow computers to read and write Kaypro, Osborne, and DEC VT-180 disks. It also sells software that allows Kaypro to read and write Osborne, Superbrain, NEC PC, Xerox, TRS-80, Morrow, Heath, Zenith, IBM PC, TI, and DEC VT-180 disks.

Port-A-Soft also offers a disk reformatting service that reformats Apple disks into other formats and converts many other disk formats into Apple-readable form. For more information on this subject, contact Port-A-Soft, 423 East 800 N, Orem, UT 84057. . . . **Steve**

In the "Affordable Tape Backup" letter in the February 1984 Ask BYTE, page 442, the price for the Pegasus 25-megabyte tape backup system was inadvertently listed as $695. The actual price is $895. We apologize for the error and any inconvenience that it may have caused.■

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 want to learn or teach someone FORTRAN, this is the package to buy."* ACCESS, March/April 1983.
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Smart Blankie

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Jim McQuaid
Analog Devices

Seven years ago, Bernie Schwarz was installing and servicing garage door openers for Sears in Cupertino, California. Today he is on the verge of bringing computer technology closer than ever before to the heart of American life. His start-up company, Sleep Smart Inc., is about to introduce the first microprocessor-based electric blanket.

This intelligent electric blanket employs advanced technology for what seems a simple purpose. The Smart Blankie senses environmental conditions and adjusts temperatures according to EEPROM (electrically erasable programmable read-only memory)-based look-up tables that can be tailored to individual preferences.

The Smart Blankie System

Like the Lisa, the Smart Blankie never truly powers off; it simply switches to a low-power state after the night is concluded. The microprocessor is a CMOS (complementary metal-oxide semiconductor) Intel 80186 for low power consumption. The 80186 cuts down on the number of support chips required. There are 32K bytes of dynamic RAM (random-access read/write memory), 82K bytes of bubble memory, and one 16K-bit EEPROM.

The flexible circuit board is long and thin so that it can fit comfortably at the foot of the bed (see figure 1). Sleep Smart chief engineer and chronic insomniac Boris Switsrick scoured Silicon Valley for a company that would make this totally nonstandard board. The company he found had previously been silk-screening plastic bottles for a large liquid-drain-opener company, so Boris concluded that they had the expertise in working with flexible supports.

The processor maintains a rolling flip-flop for historical trending and personal warmth correction.

A long ribbon cable/cord runs under the bottom sheet, carrying a pressure/temperature sensor, based on a flat-pack version of the AD590 sensor. This sensor/package combination was only available in MIL-STD versions but later testing showed that some sleepers generated combined pressure/temperature ranges that bordered on the specifications of the MIL-STD anyway.

Two additional sensor cables run through the blanket. The longitudinal sensor cable monitors temperature just under the blanket and, by integrating acceleration with a strain gage in the transverse sensor cable, measures the breathing rate or activity level of the sleeper(s). The final temperature sensor is in the manual control unit, usually placed on a nightstand or the floor; this reads the room temperature.

Sensor readings are digitized on alternate clock ticks and stored in 12-bit A/D (analog-to-digital) converter format in a series of latched storage locations. Alternate processor cycles clock data onto the local processor bus where it is ticketed for speeding if exceeding 55 mph. The processor maintains a rolling flip-flop for historical trending and personal-warmth correction. This information is written into bubble memory and summarized by a midmorning executive routine that runs once a day, after the switch to low power.

Operation

The sensor-intensive aspect of the blanket is what gives it the ability to respond to sleeping conditions. In typical use, the sleeper does not even have to turn the blanket on. The blanket immediately produces a temperature, based on the body weight, skin temperature, and room temperature, that soothes the sleeper and produces a feeling of well-being. Several minutes later, after the sleeper's breathing rate and activity level have begun to stabilize, the temperature begins to ramp down to a comfortable sleeping range but compensates for changes in room temperature. When the sleeper gets up for a period longer than twenty minutes the blanket powers down, thus saving power.

The head of Smart Blankie's software and user interface group, Thackeray ("The Hacker") Jones explains the real potential. "The factory default behavior of the system can be tailored by the user to almost any kind of requirement. We have gone out of our way to provide a user-friendly blanket." The familiar control unit on the nightstand provides complete control of the blanket's functions, including, of course, a manual override of the temperature. The blanket also has a "learning" mode with accelerated clock time so that a sleeper can "train" the blanket to respond by clock time throughout the night or perform any number of library algorithms of ramping and controlling temperatures.

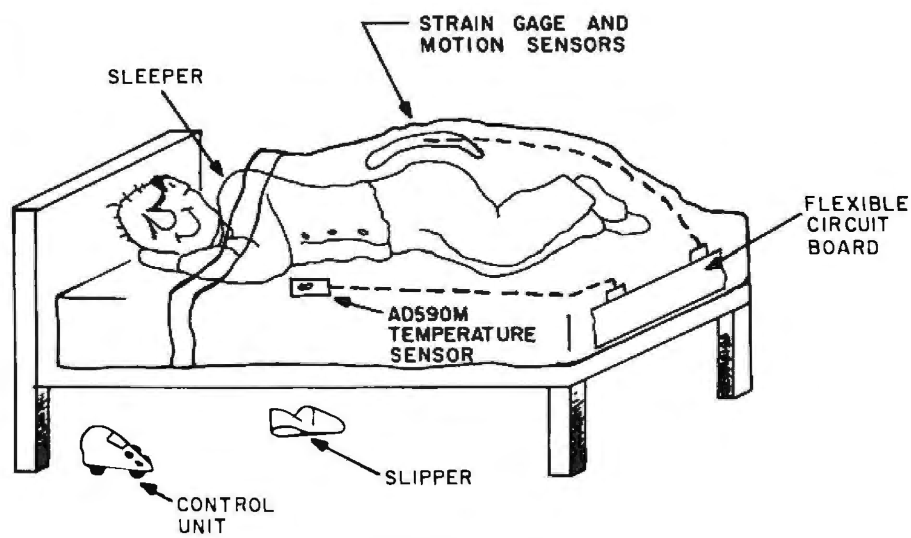


Figure 1: *The Smart Blankie operational environment.*

Accessories

At the time of product introduction there will be several accessories available. Initially, the manual control provides learning-mode control, manual override, and LED (light-emitting diode) time display. Sensing that the user interface might be critical to the success of the product, engineer Jones pushed for a voice output module as the first priority. Drawing on the system resources of the real-time clock and extensive nonvolatile memory, the voice output system enhances the soothing atmosphere with dulcet whispers (volume adjustable) for "Good Night" and appropriate levels of volume for wake-up calls.

High on the list of enhancements to be announced after first product shipments is a local-area network. The blanket, with its system intelligence, could control lights, thermostats, toasters, coffee pots, radios, and so on. Hacker Jones says that the networking protocol will be simple but the system design allows for growth. "No standard has yet emerged in HANs (home-area networks), although General Electric has talked about one." Noting that simple schemes like the BSR-X10 controllers have the widest market acceptance, Jones says that the company will support any standards that emerge.

A baby blanket, Smart Blankie jr., also is planned. The baby blanket will use the networking system to signal a parent if a rising blanket temperature and low activity levels suggest that the blanket has been kicked off.

First Impressions

I tested the Smart Blankie at Sleep Smart's modest Silicon Valley headquarters, in their Shut-Eye suite of test chambers. It was a nippy evening last February when I, forgoing the comfort of flannel PJs, slipped between the sheets, wrapped only by the Smart Blankie.

Of course production models are still unavailable, so this blanket had a few extra touches thrown in. I had just pulled up the covers and fluffed the pillow when the manual control said soothingly, "Good Night, Jim. Sleep smart!"

Of course, some bugs and reliability problems were evident. A chill overcame me around midnight as the result of a system crash. A faint whisper from the voice output droned "diurnal diurnal diurnal" again and again. My blanket was quickly rebooted and brought back on line, but Hacker Jones admitted that one elusive bug showed up in one test when both the sleeper and the date rolled over at the same time.

The Future

The blanket will sell for $149.88. While this is more than the cost of standard blankets, Schwarz feels that the market can sustain it. "We are where Betamax was seven years ago," he states. "Because we are first, we can push the learning/manufacturing curve toward complete dominance of this emerging market." He admits, however, that initial shipments of king-sized blankets will be pint-sized. Later the blanket will be downsized and the shipment rate upsized. Accessories are expected to play an important part in the success of Sleep Smart Inc. for the next 18 months.

At $149.88, Smart Blankie is not cheap. Sleep Smart may face strong competition from Westinghouse, General Electric, Hamilton-Beach, and IBM. But Bernie Schwarz says, "We have made our bed and we intend to lie in it."■

Jim McQuaid is a senior software technical writer for Analog Devices, Measurement and Control Division (Rte. 1 Industrial Park, POB 280, Norwood, MA 02062).

Special April Book Review

You'd Better Love Your BLANK Computer: The Generic Computer Book

Howard Blabbe
Blabbe Books
Hardscrabble, NH: 198*n*,
128 pages, $19.95.

Reviewed by
Duncan Mackenzie

This book represents the latest innovation by an author/publisher who has a psychotic fixation on being the first to put out a machine-specific book for a newly announced computer. A combination of electronic and printing technology have made this unique book possible. And because it's the first publication of its type (although probably not the last), this review must treat the production process more than the content.

Suppose you've just heard of the announcement of the Burndazzle Mach-19 Personal Computer—the hot new computer that the *Wall Street Journal* says will shake civilization. One hour after the Burndazzle press conference, you can go to a participating book dealer and ask to purchase a copy of *You'd Better Love Your BURNDAZZLE MACH-19 Computer.* When you ask to purchase the book, the bookstore clerk begins assembling it from the unique *You'd Better Love Your BLANK Computer* kit.

First, the clerk enters a secret code on the hidden keypad of the Blabbe Flash Printer, after which the printer's autodialing modem calls Blabbe Central. Through this high-speed link the text of Chapter 1, which contains the complete specifications of the Burndazzle Mach-19 as announced at the press conference, is downloaded and printed in the finest dot matrix on recycled newsprint.

The clerk goes to the secret Blabbe Books Customization Cache, a strongbox that can be opened only after two clerks simultaneously turn keys in key switches 8 feet apart. The Cuss Cache, as it's known in the trade, contains sets of press-on stickers that have been preprinted with the names of all computers reported to be in development by Blabbe Books' exclusive espionage corps. The clerk selects a set of Burndazzle Mach-19 stickers, carefully ignoring the similar Mach-10 and Warp-6 stickers, and inserts the stickers into the blank spaces strategically left in the generic *You'd Better Love Your BLANK Computer* main text and, of course, on the cover and title page (hence the BLANK in the generic title).

The main text, in chapters 2 through 12, covers the usual boring topics that are now required by a NATO treaty to be part of all personal-computer books: why floppy disks are better than cassette tapes (slightly inappropriate for the Burndazzle, since it uses only charge-coupled bubbles for storage, but nice to know anyway), how to write a short program in Microsoft BASIC, and how to log onto Compuserve.

Once the stickers have been stuck in, Chapter 1 tacked on to the rest of the book, and the whole thing pasted into its sealed, dust-proof jacket, you've got your complete copy of *You'd Better Love Your BURNDAZZLE MACH-19 Computer*.

The genius of Howard Blabbe was to realize that a single main text could be so easily and economically customized for each new computer on the market, using the new high technologies of on-site demand printing and gummed stickers, and that the computer-illiterate public will buy virtually any book, even one containing so little real information, as long as the name of a specific computer appears in the title.

The patented Blabbe system ensures that the freshest, most up-to-date specifications of the newest computers on the market will appear in Chapter 1 of all *You'd Better Love Your BLANK Computer* books. Just don't count on learning anything from the book that you couldn't learn from reading the press release.

Special April Letters

A Technical Solution to a Legal Problem

Your readers may be interested in a hardware modification that may help them deal with those impossible software agreements. I refer, of course, to the "warranties" that make you assume all responsibilities and give up all your rights, and to which you are supposed to have agreed the moment you break open the software's cellophane wrapper.

By enhancing the modulation circuitry in a disk drive's head driver, using three BHDs (black-hole diodes; see April 1981 BYTE, page 363), I can now read a disk while it is still in its wrapper. Because I don't open the package, I don't have to agree to the manufacturer's terms!

Of course I can't write on such disks (yet), but I never use my originals for anything anyway, except to make two backups from which I work.

Naturally, the disk drive's clutch mechanism cannot work normally with a disk that is still in its sleeve and cellophane wrapper and (usually) stiffened with a hunk of cardboard. Therefore, either the whole package or the head on its arm must spin. I have tried both methods and each works.

The first method is the more costly. I had to first saw my Apple Disk II in half to give the still-packaged disk room to rotate, then mount extensions on the clutch to engage gently enough not to tear the cellophane.

The second method is easier, if you have the parts. I had an old Sears record player, so I mounted the floppy-disk head and arm on that, then positioned the software package to be stationary as the hardware spun—just the opposite of the usual method, but, as the theory of relativity would predict, it doesn't matter whether the disk spins inside the disk drive or the disk drive spins outside the disk.

Speaking of relativity, the black-hole diodes are necessary to draw excess charge off the cellophane. As anyone who has struggled with plastic wrap knows, static buildup can be monstrous. When a charged sheet of cellophane begins to rotate at the speeds I'm talking about, it becomes a planar current, with all that entails. I actually had to use *three* BHDs!

I had originally planned to use just two

BHDs because I needed three sinks. (BHDs have two inputs each.) But I overloaded the one that I had hooked the charge wipers to, and the circuitry rapidly burned out as static buildup welded everything together. So don't take chances; use the extra charge sink.

(By the way, I followed all precautions about isolation of the BHDs. I placed each at least an inch from the rest of the circuitry, on a separate piece of perf board. Then I surrounded them with metal boxing to prevent accidental brushing against the diodes. This also helps shield against their gamma radiation and reduces the noise from the air that the black holes suck up.)

Now I'm the envy of my friends because of my stacks of unopened software that I use regularly. But little do they realize that the real payoff is in the rest I get, sleeping more easily knowing that I'm not violating the software agreements that used to make me feel so guilty.

T. Chmee Algol
Bakery Consulting
Belmont, MA 02178

April BYTE's Bits

You Heard It Here First

After reviewing U.S. census figures and the sales figures for the microcomputer industry, a distrubing trend has become apparent. Sales projections indicate that approximately 5 million personal computers will be purchased in 1984 as compared to an expected birth rate of 3.8 million children. The conclusions are obvious; computers are more popular than children.

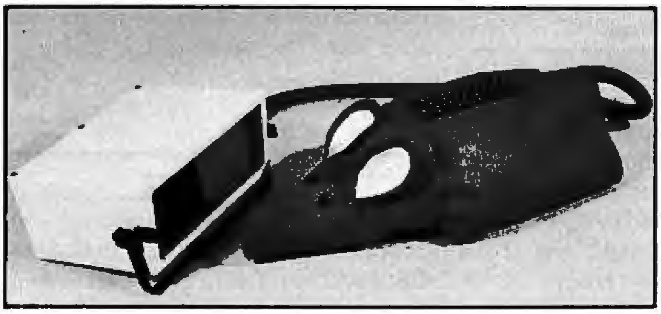
Extending the projections produces figures that show the sales of microcomputers continuing to rise while the birth rate will remain at the present level or even decline for some years into the future. "Long-range demographic trends are somewhat disturbing because of the present trend towards home computers and away from children," said Researcher Debra Hurd in an article in *Videoprint* newsletter. Ms. Hurd also noted, "Children are essential if the home computer market is to have any future at all after about the year 2040."

MacAzines

O. D. Dreggs of Clone Publishing, Coopertoni, California, announced that Clone will be publishing the first eight of its new family of magazines aimed at Macintosh owners. "Rather than wait for other publishers' magazines to appear, Clone decided to compete against itself," said Dreggs. The eight magazines include *MacBuff* for nudist users, *Mac'n'Stein* for Macintosh-owning pub owners, *MacTruk* for 18-wheeler enthusiasts, *Listen,Mac* for assertion-training graduates, *MacAdamia* for Hawaiian computer nuts, *MacDonald* for farmers, *MacRug* for toupee-wearing users, and *MacRag*, which is specifically aimed at fledgling publishers.

Special April What's New

MISCELLANEOUS



Megamaus from Vacucorp

Designed specifically to settle the burning question of the microcomputer age—Just how many buttons should a mouse have?—Megamaus includes a full ASCII keyboard. Megamaus is the first mouse-like peripheral that allows users to continue to type while moving the cursor. A companion product, Electrodent, includes only an octal-based keypad.

A product of Vacucorp, specialists in antiquated methodology, Megamaus uses a proprietary forced-air process instead of complicated electronics. Each time a key is pressed, an ASCII-compatible string of air bursts flows down the hollow Megamaus tail to the computer. "A special decoder board mounts in the computer and converts the pulses of air into those weird electronic signals," says marketing director Brucey Helmholes. Information on the Megamaus and related products can be obtained from Vacucorp, 70 Main St., Potterberough, NH 03458.

Looking for Mr. Dos

MRI (Marginal Research Inc.) of San Obscuro, California, unveiled MR-DOS, a single-user nontasking operating system package for personal computers. Tyler Sperry, founder and chief software engineer of MRI, says MR-DOS is aimed at the user "who thinks that the Unix environment is a room near the entrance to the harem and that Xenix is the Marx brother that no one can ever remember."

Instead of the traditional "A>" prompt, MR-DOS responds with the message "Well?" and the sound of impatient foot-tapping. The Help function suggests that the user read the 1466-page manual (provided at substantial extra cost).

Memory-management techniques are said to be state of the art. The booter sits on top of the CCP, which places the BDOS somewhere under the BIOS, in the middle of the TPA, but not in ROM. Headerless code in the stack registers supports overlapping segmentation in standard 256-byte addressable chunks. The allocation tables are bit-mapped to the interrupt vectors, not to mention calls to the I/O drivers from the duck blind behind the printer ports.

MR-DOS is sold in two configurations, a lower-priced edition for the novice user called Fast Eddie and a high-end edition known as Big Al. Fast Eddie provides the purchaser with both a version number and a complete sign-on message; Big Al features Marginal's System Programmer's Application Module, or S.P.A.M., a collection of futilities and infinite regresses. Purchasers of MR-DOS receive a personalized case history of their particular version and a certificate of adoption suitable for framing.

New Languages

Computechnosoft Inc. of San Luis Abysmo, Kansas, has announced two new programming languages, ORTHFAY and LIMP. ORTHFAY is an enhancement of FORTH that employs both RPN (reverse Polish notation) and PLS (Pig Latin syntax); it can be used to produce code so elegant that it becomes meaningless immediately, rather than after the weeks or months required by common FORTH variants. An interpretive language, it usually requires several attempts (and pricked fingertips) to get ORTHFAY threaded. Once loaded, however, the kernel is capable of intricate weaving and fairly decent fried chicken.

LIMP, Computechnosoft's Lisp IMPlementation, is a boon for researchers interested in lower-level higher-density artificial intelligence. Experts observe that LIMP is a much truer simulation of the human learning process than most AI languages, requiring repeated prompting and constant repetition of simple subroutines. Use of the word "Eratosthenes"—even in a remark—has been known to provoke fatal crashes.

A Real EDITER Program

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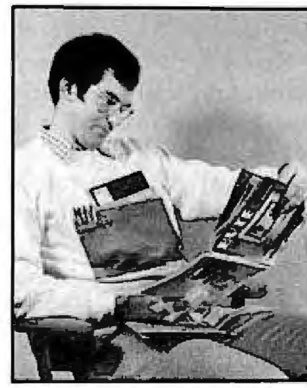
For more information, contact D. McLanahan, Cheif Ingeneer in Charge, Nadir Engineering, POB 17, Marlow, NH 03456.



Real Hacker's Shirt

Bitwear Garments of Hack 'n' Sack, Montana, has announced the availability of its Real Hacker's Shirt. This wear-only shirt is designed to put the nouveau-chic 3½-inch floppy-disk users in their places. Just because they can carry their so-called floppy disks in their shirt pockets is no reason to be glum. Thanks to Bitwear, you can flaunt your real-hacker 8-inch floppies.

This 100 percent mercerized yak-hair pullover is available in white with red, green, blue, or gold marsupial-like pouches. The handsome floppy-disk pouch is lined with an antistatic fabric and with lead foil so you can wear it during medical and dental X-rays and through airport security systems without fear of damaging your latest edition of DDT-patched code. A hard-disk version of the Real Hacker's Shirt is under development. For more information, contact Bitwear Garments, Eastern Division, The Guernsey Building, Peterbowwow, NH 03458.

Handbook of Microcomputer-Based Instrumentation and Controls

John D. Lenk
Prentice-Hall Inc.
Englewood Cliffs, NJ
1984, 384 pages
hardcover, $23.95

Reviewed by
William H. Murray

When I pick up a book in a bookstore or library I first check to see that the table of contents contains what the title implies. Secondly, I read the preface (that's where the author thanks everyone for inspiration and, if married, thanks the spouse for patience and long-suffering). Actually, the preface also usually contains an overview of what the author is attempting combined with plans to accomplish the job.

Mr. Lenk's book, *Handbook of Microcomputer-Based Instrumentation and Controls*, is a text that describes the variety of methods used currently to interface input and output devices to digital circuits and computers. Before determining this, however, I turned to the table of contents, which indicates that the college text is divided into five chapters. Chapter titles include "Introduction to Microcomputer-Based Instrumentation and Controls," "Elements of Control and Instrumentation Systems," "Elements of Microcomputer and Microprocessor-Based Systems," "Introduction to the Multiprogrammer," and "Multiprogrammer Functions and Programming Fundamentals." Based on this as a synopsis, my impression was that the book would attempt to do what the title implied—explain how to interface the real world to digital devices. I turned to the preface.

Something for Everybody

Mr. Lenk uses the preface to describe his text as "a crash course in digital or microcomputer-based instrumentation and control systems." What followed this quote has amused me more than anything I've read in months. The text was not intended for just one category of individuals, but for five: engineers, technicians, programmers/analysts, students, and hobbyists. Now before you say to yourself, How could he possibly write a meaningful text for the hobbyist and engineer alike? Mr. Lenk states, "This book bridges the gaps by bringing all these readers up to the same point of understanding. This is done in a unique manner. . . . The descriptions of how the devices operate are technically accurate (to satisfy the engineers and technicians) but are written in simple, nontechnical terms whenever possible (to benefit programmers, students, and hobbyists)." Although my first reaction was that he couldn't possibly do what he claimed, as I turned the pages of each chapter I became a believer in his unique approach.

Input and Output Methods

The 11 pages of the first chapter are used to define several fundamental terms. Input devices to a digital instrument or computer are defined as transducers or sensors while output devices are called actuators. Here, too, the author describes the basic differences and problems associated with open-loop and closed-loop control systems. I found the descriptions nontechnical and easy to understand.

Chapter 2 expands upon the definitions presented in the first chapter. It includes a discussion of just about any type of sensor or actuator that you might want to interface with a digital device or computer. All transducers are defined as one of the following 10 types: resistive, strain gauge, potentiometric, capacitive, inductive, electromagnetic, reluctive, piezoelectric, photoconductive, or photovoltaic. Having done this, he describes applications for linear motion, angular motion, speed of rotation, compression, tension, torque, acceleration, vibration, fluid flow, fluid pressure, liquid level, moisture, humidity, light, X ray, radiation, temperature, thickness, proximity, density, specific gravity, pH, and thermal-conductivity sensors. As if this were not complete enough, within each of the above categories are usually two or three methods for obtaining similar results. You should find this reading informative and interesting if you've ever done, or wondered how to do, input interfacing.

Because the transducers produce signals that are usually not directly compatible with the inputs to a digital device, Lenk thoroughly explains how these signals can be conditioned. These topics are treated from a nontechnical standpoint with the use of typical circuits and block diagrams. Also, within this section is a description of mechanical and electronic timers and counters.

Now that we know of every which way to detect data and get it properly conditioned for digital input, how do we control devices with this information? After a brief description of switches and relays, Lenk launches into the final major topic of the second chapter—the actuator. He defines an actuator as "any device that converts a signal . . . to a mechanical motion." Devices that fit this category are pusher and puller solenoids, DC motors, AC motors, valves, SCRs (silicon-controlled rectifiers), Triacs, SUSs (silicon unilateral switches), and optocouplers. I found this section a bit of a disappointment as I did not find the same descriptive detail that he used in the section on actuators.

But chapter 3 is far from a disappointment. In 68 pages the author takes us through such topics as binary and alphanumeric codes, basic digital gates, decoders, multiplexers, flip-flops, counters, shift registers, readouts, buses and ports, timing, power supplies, registers, accumulators, pointers, buffers, ALUs (arithmetic logic units), microcomputer hardware, microprocessor architecture, memory hardware, peripheral equipment, and the choice of machine language versus assembly language. This may be the only chapter in which the author is most likely to leave the student and hobbyist behind. The magnitude of the material in this chapter is enough to take your breath away, and yet Lenk jumps right in and systematically describes the fundamentals of the given topics. It would even have been appropriate if his first sentence had been "A previous knowledge of the following material will not be injurious to your health."

Multiprogrammer Devices

With definitions and descriptions out of the way, Lenk now turns the remaining two chapters to the multiprogrammer produced by Hewlett-Packard. The 6940B/6941B multiprogrammer is described as a device that "Although designed to be

controlled by HP minicomputers, desktop computers, and calculators, . . . can be operated by a number of other 16-bit controllers to provide complete automatic-test and process-control functions." The multiprogrammer is defined as a device that uses internal microprocessor-based control circuits to operate up to 15 plug-in input/output cards. Cards are purchased from the manufacturer to accomplish various tasks. The author describes the characteristics of a D/A (digital-to-analog) voltage converter, resistance output, D/A current converter, voltage regulator, low-level A/D (analog-to-digital), programmable timer, frequency reference, pulse counter, stepping-motor control, digital output, relay output, digital input, isolated digital input, event sense, process interrupt, and breadboard cards.

The remainder of the fourth chapter is devoted to applications of the multiprocessor in various production-testing operations and the programming fundamentals necessary for instrument control. Careful attention is used to describe the characteristics that might affect overall performance such as noise immunity, system protection, isolation, and troubleshooting techniques.

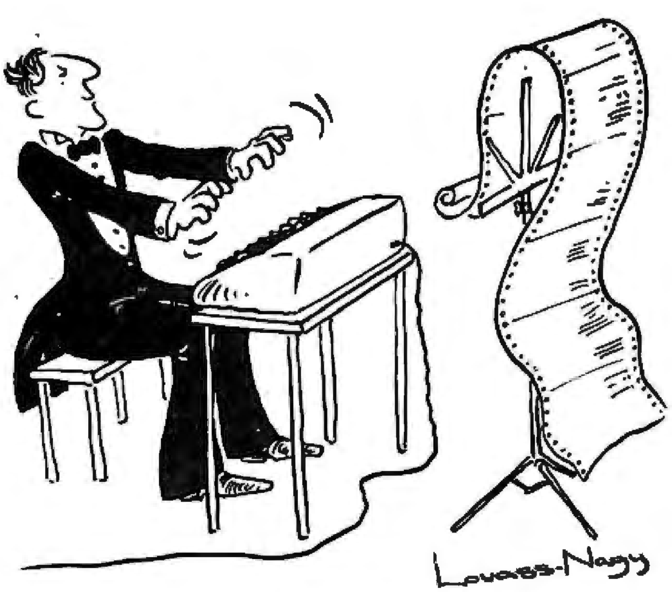
The final chapter of the book is devoted to programming techniques in order to "perform the various control and instrumentation functions." The author uses block diagrams extensively to illustrate various points of description. Topics include output modes (system enable and timing, data transfer, computer-data input, handshake, and timing) and input modes (dedicated input, timing, and interrupt/search). The final sections of this chapter describe how the various plug-in cards are programmed. In my opinion, the author has covered a tremendous amount of material in a relatively small amount of space. My only desire would be for more examples.

As a Whole

Thus, the first three chapters interface well with the concluding chapters that deal with multiprogrammer devices. They establish the input and output methods, while the last chapters explain how you can collect and analyze the data with the use of commercial devices.

If this book were to be compared with a cookbook, it would be described as one that discusses the ingredients in a recipe without giving the actual proportions. Now this has both its good and bad points. First, I believe the author accomplished his task—the book is a crash course in microcomputer-based instrumentation geared to the levels of individuals from various backgrounds. Second, the book was not intended to be a source of various interface circuits but rather a source of techniques. (Perhaps like the steps in baking a fruit pie without going into detail on the type of fruit filling). And so, this is a highly valuable book on the techniques of interfacing, leaving the actual implementation to the reader. ■

William H. Murray (RD 3, Box 363, Montrose, PA 18801) is a professor of computer science at Broome Community College in Binghamton, NY 13902.



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Microcomputer Interfacing

Harold S. Stone
Addison-Wesley
Publishing Co. Inc.
Reading, MA
1982, 383 pages
hardcover, $32.95

Reviewed by
Stephen Locke

I know what you're thinking—another book on microcomputer interfacing. Indeed, the proliferation of computer book titles has never been greater in the publishing business than now. So many people are searching for knowledge on this complicated subject that it seems some publishers and writers are producing books that are a waste of the reader's time. *Microcomputer Interfacing* by Harold S. Stone is not one of those.

This is a text book and, as such, is intended for both undergraduate and professional readers. The undergraduates should be majoring in computer engineering or enrolled in a computer-science program that exposes them to logic design, assembly-language programming, and a high-level language. This prior knowledge is recommended before reading this book. However, I found the only background knowledge I needed was about the meaning of the logic-gate symbols and flip-flops. I saw no need for a high-level language background. But it would help you to be very familiar with transistors, microprocessors, and assembly language in order to get the most value from reading this book. A mathematics background is assumed in the mention of LaPlace transforms in a section on phase-locked loops. (Phase-locked loops are used in magnetic disk-read circuits to quickly lock onto the frequency of the clock data that is imbedded in the data-signal read from the disk. This effectively rejects noise.) You may have to skip this section if your math skills are not up to par.

An Overview

Many of the chapters cover a discussion of basic principles, methods and detailed examples of applying these principles, suggested laboratory experiments, and nonlaboratory problems. As the author points out, the basic principles of microprocessor technology are important enough to continue into the future. However, detailed examples given in this text use technology and integrated circuits (ICs) available at the time this book was written and may soon be obsolete.

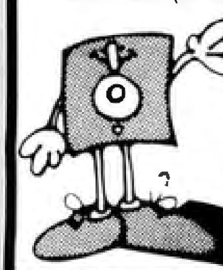
Following the book's index is a numerical index of the 98 IC devices referred to in the text. The book's main index is expanded to include a definition of terms used. This index/glossary is especially useful in a field that contains so many acronyms and new terms. Also, the bibliography contains numerous references for those who may wish to seek further information.

As a whole, this book is written for future designers rather than service people or hobbyists. But I've found that if you know how a microprocessor system works and was designed, you can do a better job of repairing, modifying, and designing attachments. A lot of practical information is supplied about techniques for connecting computers to peripherals and communication devices and also about the method for programming the computer to control external devices.

Specifics

The author includes a much-needed chapter on shielding, grounding, and transmission-line techniques. When the length of a TTL (transistor-transistor logic) line becomes more than about 18 inches, the line should be considered as a transmission line and treated as such to prevent glitches. Glitches are due to the signal's bouncing off the end of the line and being reflected back to the source, and can be analyzed by transmission-line design techniques.

A list of ICs used for receivers and transmitters for communication lines (to remote terminals) is offered with recommendations. The author stresses common-mode rejection as the most important parameter, due to



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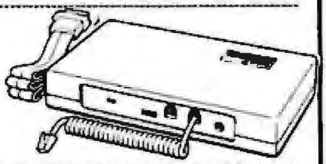

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Harold S. Stone, the author of Microcomputer Interfacing *and a professor at the University of Massachusetts at Amherst, has authored an accompanying set of 12 videocassettes called* Microprocessor Interfacing *that supplement this text book, turning the combination into a veritable course in engineering. The tapes are produced and distributed by the Association of Media-based Continuing Education for Engineers (AMCEE), as well as distributed by Addison-Wesley. Each one runs about 40 minutes and is divided into theory and lab experiments. This is useful because you don't have to set up the experiment yourself, much time is saved, and experiments shown on videotape work every time. The complete course is $3600; a 12-week rental is $1080; a preview package is $115 and includes a study guide published by AMCEE; and transparencies for classroom use are $15.95. Contact AMCEE, 225 North Ave. NW, Atlanta, GA 30332.*

high AC and/or DC voltages across local and remote electrical grounds.

One section includes a case history of a computer that was connected to a terminal located in another building. Because the system burned out when lightning struck nearby, recommendations are given for an improved design.

I appreciated reading the history of minicomputer bus systems and protocol schemes. For background information is a discussion of the DEC PDP-8 and PDP-11 bus protocol and IBM's bisync communication design. Although many would consider these systems obsolete, there are enough of them in use today so that the information can be quite useful.

But the range of this book provides something for people representing a variety of interests. The first chapter covers the various structures of microcomputers including input/output interfacing techniques. Methods for safe connections with transmission lines, bus connections, and memory systems are covered in the next few chapters. Serial and parallel interfacing techniques, magnetic recording, design, and development of software precede the convenient glossary mentioned earlier.

On the Other Hand

I believe the section on the IEEE-488 interface standard could be improved by a more detailed description. Although nine pages were devoted to this interface, I would have appreciated an example of a complicated system with assembly programs given. Also, the interface can be used in a simple way by not using all control lines, but this was not pointed out in the book.

I also found there was no discussion of a Universal Asynchronous Receiver/Transmitter (UART). This popular IC deserves a little space, although I admit, if you can understand the chapters on serial and parallel communication, you would not have any trouble using a UART with the assistance of a manufacturer's data sheet. But you would have to know such a device existed.

Some confusion exists in the book between DMA (direct memory access) and cycle-steal operations. It is my understanding that during DMA the processor must relinquish control of certain lines and buses to the I/O device. These are the address bus, data bus, and some control lines. A peripheral device can gain control of both buses and these control lines through the use of tri-state-drivers. Cycle-steal operations are similar except that the address lines from the processor are not disconnected and the processor generates addresses for the I/O device. I would have liked this minor confusion cleared up.

Because the writing style is clear and compact, I can recommend the purchase of this book to anyone with an engineering background and the desire to understand a sometimes complicated subject.■

Stephen Locke is a consulting engineer residing at 817 Belair Dr., Darien, IL 60559.

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Morrow Users Convene in DC

The Morrow User Group of Washington, DC, meets at 7:30 p.m. on the second Tuesday of the month in the Washington metropolitan area. Users of the Morrow Designs Micro Decision line who become members can benefit from a discussion of problems, distribution of public-domain software, instructional courses, a monthly newsletter, and group-purchase discounts. A computerized bulletin-board service is planned. Annual dues are $25. For details, contact the Morrow User Group of Washington, DC, POB 832, Arlington, VA 22216, (301) 277-3760.

Tips on Investments

The Microcomputer Investors Association (MCIA), a professional, nonprofit association, is part of an information network that uses microcomputers to make and manage investments. A journal, *The Microcomputer Investor*, which is produced twice a year, contains articles and programs. For an information packet, send $5 to Dr. Jack Williams, MCIA, 902 Anderson Dr., Fredericksburg, VA 22405.

Curious About Robots?

The Colorado Parents of Robots, a robot users group in the early stages of development, meets at 7:30 p.m. on the third Thursday of each month in Denver, Colorado. There are no dues. All interested persons are encouraged to contact P. J. Scardino for details at the Colorado Parents of Robots, 12351 West 64th St., Arvada, CO 80004, (303) 421-6361.

Computer Club in South Africa

The Cape Computer Club in Cape Town, South Africa, meets on the first Thursday of each month at the Athenaeum in Newlands and welcomes new members, user group information, and newsletters from groups around the world. Directed toward the hobbyist, the club supports at least seven special-interest groups for various computers. The *Cape Computer Club Print Out* or *C3PO* is produced each month and is free to members. It contains a fleamarket, letters, and articles. The club sponsors classes prior to meetings, maintains a library, and provides purchase discounts. The annual subscription is R15; R8 for students and country members. For further information, contact the Cape Computer Club, POB 6251, Roggebaai 8012, South Africa.

Yavapai County CP/M Users Unite

The Yavapai County CP/M Users Group serves users of Osborne, Kaypro, IMSAI, and Commodore 64 computers. The club meets monthly in Prescott, Arizona, and maintains a disk library of public-domain programs. For details, contact Julie Woodman, POB 68, Kirkland, AZ 86332.

A Clearinghouse for 9000 Fellow Users

The Inter-Galactic Victor/Sirius Users Group of Scottsdale, Arizona, produces *Problem Solvers Unanimous (PSU)*, a newsletter that is designed to educate subscribers both in the U.S. and abroad who use or sell the Victor 9000. *PSU* keeps track of a dozen Victor users groups and almost ten Victor publications. All Victor users are invited to participate. Members receive software discounts. A 12-month subscription is $36. For details, contact Joe and Ann Reid, *PSU* Newsletter, POB 3244, Scottsdale, AZ 85257, (602) 946-5948.

PC Active in the Rockies

The PC Users Group of Colorado, formerly called the Denver Users Group, meets at 7 p.m. on the last Thursday of every month in the Capital Federal Savings Building in Boulder. A subscription to the newsletter, *Pcock*, is included in the $12 annual membership fee. For further details, contact Howard Weissman, PC Users Group of Colorado, POB 944, Boulder, CO 80306, (303) 443-5528 evenings.

CP/Morrow in Sacramento

The CP/Morrow Computer Group meets on the first Thursday of each month in Sacramento, California. It welcomes correspondence with other CP/M-oriented groups. A $12 annual membership includes a subscription to the monthly newsletter. For further information, contact the CP/Morrow Computer Group, POB 654, Carmichael, CA 95608.

Apple Users Meet in Ontario

The Apple Users Group, affiliated with Microcomputer Users International, serves Apple users in Michigan and the Sault Ste. Marie area of Canada. Production of a monthly newsletter is planned. For meeting times and locations, contact Bert Williams, 47 Tuckett St., Sault Ste. Marie, Ontario P6A 4G8, Canada, (705) 254-1459.

Bowling Green Hosts Computerists

The Bowling Green Commodore Users Group serves users of the Commodore 64 in the vicinity of Bowling Green, Kentucky. The club welcomes any new members from the surrounding areas. For further details, contact Alex Fitzpatrick, Creekside Apt. #6, Route 11, Bowling Green, KY 42101, (502) 781-9098.

Ecumenical Computer Exchange Formed

A computer-exchange association has been formed to aid member churches in the acquisition of computers and word-processing equipment at the lowest possible costs. Churches of all denominations are welcome to participate in this endeavor sponsored by the Unitarian Universalist Churches of central Ohio. For information, send a self-addressed, stamped envelope to the

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Cottage Industry Revisited

Cottage Computing, a monthly publication from Home Business News, contains articles and items of interest for anyone planning to make his or her computer pay for itself. Educational- and household-computing articles are included with news of events, business ideas, bulletin-board listings, and reviews of hardware, software, and books. Advertisement rates are available upon request. Issues are $1 each or $12 for one year. For details, contact *Cottage Computing*, Home Business News, 12221 Beaver Pike, Jackson, OH 45640.

New Age Homebrew

The Homebrew Robots of San Francisco, California, is a forum where robot builders and experimenters can exchange ideas, experience, skills, and equipment. For details, contact Bob Platt, Homebrew Robots of San Francisco, Heald College, Technical Division, 150 4th St., San Francisco, CA 94103.

Epson Users Cooperate

The Epson QX-10 Users Group of Lemont, Pennsylvania, produces a newsletter, offers a cooperative plan for member discounts, and distributes public-domain programs. Advertisements are free for members. Annual dues are $20, a family membership is $25, and student memberships are $15. For details, contact Epson QX-10 Users Group, Box 1076, Lemont, PA 16851.

Notes from a Bug

To promote information interchange and an understanding of the IBM Personal Computer and compatible computers, the CDP Baltimore Users Group (BUG) meets regularly and welcomes all interested parties. Users of Columbia Data Products (CDP) MPC and VP are welcome. A newsletter, the *Bugletter*, is produced. For details, contact the CDP Baltimore Users Group, POB 223, Owings Mills, MD 21117.

Trading Post for Computers or Disks

Trade-a-comp/Trade-a-disk is a monthly newsletter for those wanting to buy, sell, or trade new and used computer hardware and software. The readership includes first-time home-computer or business users and employers seeking specialists and vice versa. An ad must contain a minimum of 20 words; each word costs $0.15 per issue. A subscription is $18 for one year or $10 for six months. For information, contact *Trade-a-comp/Trade-a-disk*, POB 671, Bethel Park, PA 15102.

Ample Apple Groups in Schools

The Apple Computer Clubs, an organization designed to bring together elementary and secondary school students who want to share their experiences in computing, expects to assist over 10,000 schools in starting Apple Computer Clubs. The club issues a kit of materials that contains information about how to start a club, maintains a library of resources for club members, produces publications, posters, manuals, a bimonthly newsletter, and other supplementary materials. For fur-

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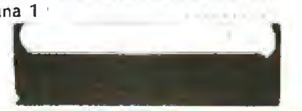

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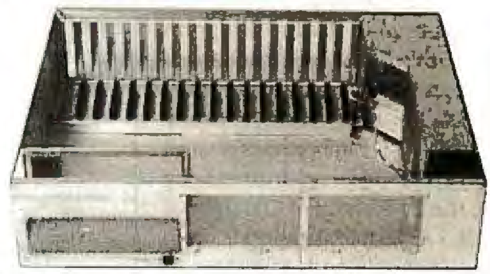

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The Oklahoma Educational Computer Users Program (OECUP) invites teachers of computer-related mathematics and mathematically gifted students to classes and conferences sponsored by the University of Oklahoma. OECUP membership is open to schools and educators in Oklahoma as well as from neighboring states. Free disks of public-domain software for the TRS-80 and Apple computers are distributed to members. The group also announces grants, contest opportunities, magazines, and invitations to participate in computer-related events. The University of Oklahoma's 50-microcomputer laboratory is open for use by secondary school teachers and students. The first-year membership is $35, which includes a year's subscription to the journal of the International Council for Computers in Education, *The Computing Teacher*. Thereafter the membership is $25 annually. For further information, contact Dr. Richard V. Andree, Mathematics Department, 601 Elm St., University of Oklahoma, Norman, OK 73019.

Down in the Valley

The Delaware Valley DEC PC Users Group meets quarterly at Digital headquarters in Blue Bell, Pennsylvania. It produces a newsletter that is distributed one month before the meetings. Annual dues are $10. For further details, contact Tom Deahl, 815 Carpenter Lane, Philadelphia, PA 19119, (215) 848-4545.

New Horizons for Timex/Sinclair

T-S Horizons, affiliated with the Portsmouth, Ohio, Area Timex/Sinclair User Group, contains programming articles, hardware modifications, business- and home-finance modifications, and numerical or statistical analyses for the Timex/Sinclair 1000, 1500, and 2068. For further details, contact Rick Duncan, *T-S Horizons*, 2002 Summit St., Portsmouth, OH 45662, (614) 354-2563.

PCs and the Law

The Lawyer's PC is a twice-monthly newsletter for lawyers who use the IBM PC or compatible brands in their practices. It offers guidelines on applying computers to the law office. Another publication in the same genre is produced for users of TRS-80s, *The Lawyer's Microcomputer* (see December 1982, page 505). An annual subscription for either publication is $58 in the U.S., $70 in Canada and Mexico, and $94 overseas. For details, contact R.P.W. Publishing Corp., POB 1046, Lexington, SC 29072, (803) 359-9941.

Keep Up with PACE

The Pittsburgh Atari Computer Enthusiasts (PACE) meet at 7 p.m. on the second Thursday of every month in the Marriott Green Tree in Pittsburgh, Pennsylvania. The monthly newsletter, *Keeping PACE*, contains software reviews, news updates, and a list of the programs maintained in the disk library. Annual membership is $20, which includes the newsletter. For information, contact W. H. Cleis, PACE, 60 Clover Dr. Apt. 30, Pittsburgh, PA 15236.

Talk with Victor

Users, sellers, potential owners, and distributors of the Victor 9000 and related products are welcome to receive the monthly newsletter of the Victor Group, *Victor Talk*. The $30 annual membership fee can be sent to *Victor Talk*, 1850 Union St. #498, San Francisco, CA 94123.■

If you would like BYTE readers to know about your club or newsletter send the details accompanied by no more than one newsletter to Clubs and Newsletters, BYTE Publications, POB 372, Hancock, NH 03449. Overseas groups are encouraged to participate. Please allow at least three months for your announcement to appear.

BYTE's Bugs

Missing Bracket Mars Program

A missing bracket in David Clark's source code of Lmodem.c results in a "While Missing" error statement. (See "Lmodem: A Small Remote-Communication Program," November 1983, page 410.)

Between the end of the listing on page 418 and its resumption on page 420, a closing curly bracket should be added. The bracket is required to close the compound statement that started with the conditional statement

if (firstchar == SOH).■

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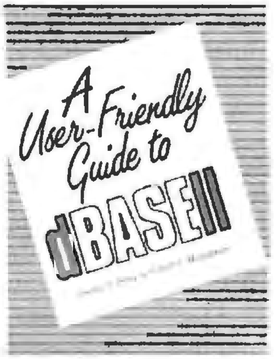

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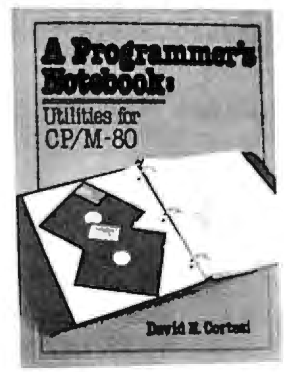

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If you own or are considering the purchase of dBASE II (the widely-used data base management system), Perry and McJunkins also give you a complete overview of dBASE II and the commands and routines you need to use it effectively.
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Books Received

Advanced Microprocessors, Amar Gupta and Hoo-min Toong, eds. New York: John Wiley and Sons, 1983; 368 pages, 22.3 by 28.8 cm, hardcover, ISBN 0-471-88176-7, $41.50.

The Amazing Race, William H. Davidson. New York: John Wiley & Sons, 1984; 288 pages, 15.8 by 23 cm, hardcover, ISBN 0-471-88711-0; $17.95.

Animation, Games, and Sound for the IBM PC, Tony Fabbri. Englewood Cliffs, NJ: Prentice-Hall, 1983; 208 pages, 17.5 by 23.5 cm, softcover, ISBN 0-13-037689-2, $16.95.

Apple II BASIC, David C. Goodfellow. Blue Ridge Summit, PA: Tab Books, 1983; 240 pages, 19.8 by 23.3 cm, softcover, ISBN 0-8306-1513-X, $13.50.

The Apple II Circuit Description, Winston D. Gayler. Indianapolis, IN: Howard W. Sams & Co., 1983; 264 pages, 21.3 by 28 cm, spiral-bound, ISBN 0-672-21959-X, $22.95.

Applesoft Language, 2nd ed. Brian D. Blackwood and George H. Blackwood. Indianapolis, IN: Howard W. Sams & Co., 1983; 280 pages, 15.3 by 23 cm, spiral-bound, ISBN 0-672-22073-3, $13.95.

The Art of Problem Posing, Stephen I. Brown and Marion I. Walter. Philadelphia, PA: The Franklin Institute Press, 1983; 160 pages, 15 by 22.8 cm, softcover, ISBN 0-89168-052-7, $11.95.

Artificial Intelligence, A. M. Andrew. Philadelphia, PA: Heyden & Son Inc., 1983; 216 pages, 16 by 24.3 cm, hardcover, ISBN 0-85626-165-3, $33.

Better BASIC for the Apple, J. N. P. Hume and R. C. Holt. Reston, VA: Reston Publishing Co., 1983; 304 pages, 17.3 by 23.3 cm, softcover, ISBN 0-8359-0466-0, $14.95.

BASIC Fun, Susan Drake Lipscomb and Margaret Ann Zuanich. New York: Avon Books, 1982; 176 pages, 13 by 19 cm, softcover, ISBN 0-380-80606-1, $2.25.

BASIC by Design, Andrew Kitchen. Englewood Cliffs, NJ: Prentice-Hall, 1983; 512 pages, 17.5 by 23.3 cm, softcover, ISBN 0-13-060269-8, $18.95.

BASIC for Microcomputers, Roger W. Haigh and Loren E. Radford. New York: Van Nostrand Reinhold, 1983; 350 pages, 19.5 by 24.5 cm, hardcover, ISBN 0-442-27843-8, $22.45.

Basics of Timex/Sinclair 1000, ZX81 BASIC, Allen H. Wolach. Reston, VA: Reston Publishing Co., 1983; 208 pages, 15.5 by 23.5 cm, hardcover, ISBN 0-8359-0425-0, $16.95.

The Big Trak Book, Tom Rowley and Ron Leckrone. Reston, VA: Reston Publishing Co., 1984; 128 pages, 21 by 28 cm, softcover, ISBN 0-8359-0478-4, $12.95.

Bits, Bytes & Buzzwords, Mark Garetz. New York: New American Library, 1983; 160 pages, 10.5 by 17.8 cm, softcover, ISBN 0-451-12841-9, $2.95.

Building Controls into Structured Systems, Alan E. Brill. New York: Yourdon Press, 1983; 168 pages, 15.3 by 22.8 cm, softcover, ISBN 0-917072-27-8, $29.

CP/M Primer, 2nd ed. Stephen Murtha and Mitchell Waite. Indianapolis, IN: Howard W. Sams & Co., 1983; 156 pages, 18.5 by 23 cm, softcover, ISBN 0-672-22170-5, $16.95.

Common Algorithms in Pascal with Programs for Reading, David V. Moffat. Englewood Cliffs, NJ: Prentice-Hall, 1984; 238 pages, 17.3 by 23.3 cm, softcover, ISBN 0-13-152637-5, $8.95.

Computability, George J. Tourlakis. Reston, VA: Reston Publishing Co., 1984; 576 pages, 18 by 24.3 cm, hardcover, ISBN 0-8359-0876-4, $27.95.

Computer Aided Design, Raphael Kaplinsky. New York: Macmillan Publishing Co., 1982; 144 pages, 16 by 23.5 cm, hardcover, ISBN 0-02-949520-2, $22.95.

Computers for Everybody, Jerry Willis and Merl Miller. New York: New American Library, 1983; 272 pages, 10.5 by 17.8 cm, softcover, ISBN 0-451-12840-0, $3.50.

Computer Literacy: The Basic Concepts and Language, John V. Lombardi. Bloomington, IN: Indiana University Press, 1983; 128 pages, 15.5 by 23.3 cm, softcover, ISBN 0-253-21075-5, $5.95.

The Computer Tutor: Atari Home Computer Edition, Gary W. Orwig and William S. Hodges. Boston, MA: Little, Brown & Co., 1983; 368 pages, 21.5 by 28 cm, softcover, ISBN 0-316-66502-9, $15.95.

Designing Structured Programs, David Higgins. Englewood Cliffs, NJ: Prentice-Hall, 1983; 256 pages, 17.5 by 23.5 cm, softcover, ISBN 0-13-201418-1, $14.95.

Dictionary of Computing, Valerie Illingworth, Edward L. Glaser, and I. C. Pyle, eds. New York: Oxford University Press, 1983; 408 pages, 16 by 24.3 cm, hardcover, ISBN 0-19-853905-3, $24.95.

The DIF File, Donald H. Beil. Reston, VA: Reston Publishing Co., 1983; 254 pages, 17.5 by 23.5 cm, softcover, ISBN 0-8359-1305-8, $15.95.

Discrete Mathematics for Computer Scientists, Joe L. Mott, Abraham Kandel, and Theodore P. Baker. Reston, VA: Reston Publishing Co., 1983; 576 pages, 18.3 by 24.3 cm, hardcover, ISBN 0-8359-1372-4, $27.95.

Discrete Mathematics: A Computational Approach Using BASIC, Marvin Marcus. Rockville, MD: Computer Science Press, 1983; 352 pages, 14.3 by 22.8 cm, spiral-bound, ISBN 0-914894-38-2, $19.95.

Does Your Small Business Need A Computer?, Martha Eischen. Blue Ridge Summit, PA: TAB Books, 1982; 168 pages, 13 by 21 cm, softcover, ISBN 0-8306-0624-6, $10.95.

8080/8085 Assembly Language Subroutines, Lance A. Leventhal and Winthrop Saville. Berkeley, CA: Osborne/McGraw-Hill, 1983; 496 pages, 18.5 by 23.5 cm, softcover, ISBN 0-931988-58-6, $15.95.

Elementary Fortran with Scientific & Business Applications, Frank C. Lin. Reston, VA: Reston Publishing Co., 1983; 350 pages, 15.3 by 23 cm, softcover, ISBN 0-8359-1696-0, $15.95.

Encyclopedia of Computer Science and Engineering, 2nd ed. Anthony Ralston, ed. New York: Van Nostrand Reinhold, 1983; 1700 pages, 20 by 24.3 cm, hardcover, ISBN 0-442-24496-7, $87.50.

The Executive's Guide to the IBM Personal Computer, Alan J. Parker. Reston, VA: Reston Publishing Co., 1983; 304 pages, 21 by 25.5 cm, hardcover, ISBN 0-8359-1809-2, $49.95. Includes two floppy disks.

Experiments with Integrated Circuits, Richard J. Higgins. Englewood Cliffs, NJ: Prentice-Hall, 1983; 240 pages, 21 by 28 cm, softcover, ISBN 0-13-295527-X, $14.95.

Fundamentals of Programming Languages, 2nd ed. Ellis Horowitz. Rockville, MD: Computer Science Press, 1984; 464 pages, 15.8 by 23.8 cm, hardcover, ISBN 9-88175-004-2, $26.95.

FORTRAN 77, V. A. Dyck, J. D. Lawson, and J. A. Smith. Reston, VA: Reston Publishing Co., 1984; 720 pages, 18.5 by 24.3 cm, hardcover, ISBN 0-8359-3163-3, $23.95.

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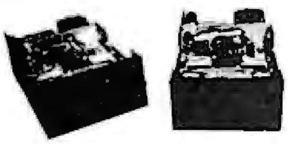

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Genesis II, Creation and Recreation with Computers, Dale Peterson. Reston, VA: Reston Publishing Co., 1983; 224 pages, 21.5 by 27.8 cm, softcover, ISBN 0-8359-2433-5, $15.95.

Getting Started with 8080, 8085, Z80, and 6800 Microprocessor Systems, James W. Coffron. Englewood Cliffs, NJ: Prentice-Hall, 1984; 352 pages, 17.8 by 23.5 cm, softcover, ISBN 0-13-354663-2, $14.95.

A Guide for Selecting Computers and Software for Small Businesses, Paul G. Enockson. Reston, VA: Reston Publishing Co., 1983; 128 pages, 24 by 18 cm, hardcover, ISBN 0-8359-2642-7, $19.95.

Handbook of Microcomputer-Based Instrumentation and Controls, John D. Lenk. Englewood Cliffs, NJ: Prentice-Hall, 1984; 320 pages, 15.5 by 23.7 cm, hardcover, ISBN 0-13-380519-0, $24.95.

How to Maintain and Service Your Small Computer, John G. Stephenson and Bob Cahill. Indianapolis, IN: Howard W. Sams & Co., 1983; 210 pages, 21.3 by 28 cm, softcover, ISBN 0-672-22016-4, $17.95.

How to Program Your IBM PC, Advanced BASIC Programming, Carl Shipman. Tucson, AZ: HP Books, 1983; 272 pages, 21.3 by 28 cm, 3-ring binder, ISBN 0-89586-264-6, $14.95.

How to Select and Buy a Personal Computer, Ursula Connor. Old Greenwich, CT: Devin-Adair Publishers, 1983; 200 pages, 15 by 23 cm, softcover, ISBN 0-8159-5717-3, $9.95.

How To Use The IBM Personal Computer, Steven Manus. Sherman Oaks, CA: Alfred Publishing Co., 1983; 64 pages, 10.8 by 28 cm, softcover, ISBN 0-88284-234-X, $2.95.

IBM PC Conversion Handbook of BASIC, J. Mel Harris and Michael J. Scofield. Englewood Cliffs, NJ: Prentice-Hall, 1983; 176 pages, 14.5 by 23 cm, softcover, ISBN 0-13-448481-9, $12.95.

The IBM PC Connection, Neil L. Shapiro. New York: Micro Text/McGraw-Hill, 1983; 208 pages, 15.3 by 23.8 cm, softcover, ISBN 0-07-056419-1, $16.95.

IBM PC Expansion & Software Guide, 2nd ed. Que Corp. Indianapolis, IN: Que Corp., 1983; 584 pages, 21 by 28 cm, softcover, ISBN 0-88022-027-9, $16.95.

Intelligent Systems, The Unprecedented Opportunity, J. E. Hayes and D. Michie, eds. New York: John Wiley & Sons, 1983; 224 pages, 15.5 by 23.7 cm, hardcover, ISBN 0-470-27501-4, $39.95.

Interactive Computer-Based Systems, Stephen J. Andriole. Princeton, NJ: Petrocelli Books, 1983; 152 pages, 16.3 by 24 cm, hardcover, ISBN 0-89433-191-4, $16.95.

Interfacing to the IBM Personal Computer, Lewis C. Eggebrecht. Indianapolis, IN: Howard W. Sams & Co., 1983; 248 pages, 20.3 by 23.5 cm, softcover, ISBN 0-672-22027-X, $15.95.

An Introduction to Programming the ORIC-1, R. A. and J. W. Penfold. London, England: Bernard Babani Ltd., 1983; 112 pages, 11 by 17.8 cm, softcover, ISBN 0-85934-104-6, £1.95.

Introduction to the Theory of Automata, Zamir Bavel. Reston, VA: Reston Publishing Co., 1983; 672 pages, 18.5 by 24.3 cm, hardcover, ISBN 0-8359-3271-5, $27.95.

An Introduction to Visicalc Spreadsheeting for the TRS-80 Model II and Model 16, Harry Anbarlian. New York: McGraw-Hill, 1983; 368 pages, 15.5 by 23.5 cm, spiral-bound, ISBN 0-07-001596-1, $49.95. Includes 8-inch floppy disk.

An Introduction to Vu-Calc Spreadsheeting for the Timex/Sinclair 1000 and the Sinclair ZX-81, Harry Anbarlian. New York: McGraw-Hill, 1983; 258 pages, 15.8 by 23.5 cm, spiral-bound, ISBN 0-07-001699-2, $22.95.

Invitation to FORTRAN for the TRS-80, Lawrence L. McNitt. New York: Petrocelli Books, 1983; 248 pages, 15.3 by 23.3 cm, softcover, ISBN 0-89433-210-4, $15.

Kensei, Steven Schlossstein. New York: Congdon & Weed Inc., 1983; 350 pages, 16 by 24.5 cm, hardcover, ISBN 0-86553-089-0, $15.95.

Learning and Teaching with Computers, Tim O'Shea and John Self. Englewood Cliffs, NJ: Prentice-Hall, 1983; 320 pages, 14.5 by 23.5 cm, softcover, ISBN 0-13-527762-0, $12.95.

Learning and Teaching Programming Using The TRS-80 Model III, Nancy Lee Olsen. Indianapolis, IN: Howard W. Sams & Co., 1983; 128 pages, 21.5 by 28 cm, spiral-bound, ISBN 0-672-22072-5, $10.95.

Megabucks From Your Microcomputer, Timothy Orr Knight. Indianapolis, IN: Howard W. Sams & Co., 1983; 72 pages, 21.3 by 27.8 cm, softcover, ISBN 0-672-22083-0, $3.95.

Microcomputer Programming with Microsoft BASIC, Robert G. Crawford and David T. Barnard. Reston VA: Reston Publishing Co., 1984; 432 pages, 17.5 by 23.5 cm, softcover, ISBN 0-8359-4356-9, $15.95.

The NSC800 Microprocessor Cookbook, Roger C. Alford. Blue Ridge Summit, PA: Tab Books, 1983; 280 pages, 13 by 21 cm, softcover, ISBN 0-8306-1502-4, $12.95.

1984 Computer Desk Diary, Gil Roeder and Jason A. Shulman. New York: Workman Publishing, 1983; 196 pages, 20.3 by 10 cm, spiral-bound, ISBN 0-89480-586-X, $8.95.

100 Ready-To-Run Programs & Subroutines for the IBM PC, Jeff Bretz and John Clark Craig. Blue Ridge Summit, PA: Tab Books, 1983; 320 pages, 19.8 by 23.3 cm, softcover, ISBN 0-8306-1540-7, $16.50.

A Parent's Guide to Personal Computers & Software, the editors of *Consumer Guide* with Danny Goodman. New York: Simon & Schuster, 1983; 64 pages, 21 by 27.5 cm, spiral-bound, ISBN 0-671-49173-3, $6.95.

Pascal Programming: A Beginner's Guide to Computers and Programming, Chris Hawksley. Cambridge, England: Cambridge University Press, 1983; 218 pages, 15.5 by 23.5 cm, hardcover, ISBN 0-521-25302-0, $24.95.

The Personal Computer Glossary, George Ledin Jr. Sherman Oaks, CA: Alfred Publishing Co., 1983; 64 pages, 10.8 by 28 cm, softcover, ISBN 0-88284-233-1, $2.95.

Personal Pascal, David E. Cortesi and George W. Cherry. Reston, VA: Reston Publishing Co., 1984; 432 pages, 17.5 by 23.5 cm, softcover, ISBN 0-8359-5522-2, $16.95.

Pocket Guide to CP/M, Thomas A. Dwyer and Margot Critchfield. Reading, MA: Addison-Wesley, 1983; 100 pages, 10 by 15.8 cm, spiral-bound, ISBN 0-201-10363-X, $7.25.

Pocket Guide to Wordstar, Tony Bove and Cheryl Rhodes. Reading, MA: Addison-Wesley, 1983; 75 pages, 10 by 15.8 cm, spiral-bound, ISBN 0-201-07754-X, $7.25.

The Power Of: 1-2-3, Robert E. Williams. Portland, OR: Management Information Source Inc., 1983; 184 pages, 20.8 by 26.8 cm, softcover, ISBN 0-13-687525-4, $14.95.

The Power Of: VisiCalc, vol. 1 and 2, Robert E. Williams, Bruce J. Taylor, and Brian L. King. Portland, OR: Management Information Source Inc., 1982; 192 pages, 21 by 27.3 cm, softcover, ISBN 0-13-687418-5, $14.95.

Proven Techniques for Troubleshooting the Microprocessor and Home Computer Systems, James W. Coffron. Englewood Cliffs, NJ: Prentice-Hall, 1984; 256 pages, 17.5 by 23.5 cm, softcover, ISBN 0-13-731738-7, $14.95.

Relational Information Systems, T. H. Merrett. Reston, VA: Reston Publishing Co., 1984; 528 pages, 18 by 24.5 cm, hardcover, ISBN 0-8359-6642-9, $24.95.

Robotics and Automated Manufacturing, Richard C. Dorf. Reston, VA: Reston Publishing Co., 1983; 208 pages, 15.8 by 23.5 cm, hardcover, ISBN 0-8359-6686-0, $24.95.

Science and Engineering Programs for the IBM PC, Cass Lewart. Englewood Cliffs, NJ: Prentice-Hall, 1983; 144 pages, 14.5 by 23 cm, softcover, ISBN 0-13-794917-0, $12.95.

Sprites, A Turtle, and TI LOGO, Jim Conlan and Don Inman. Reston, VA: Reston Publishing Co., 1984; 240 pages, 15.3 by 23 cm, softcover, ISBN 0-8359-7036-1, $14.95.

Structured Digital Design Including MSI/LSI Components and Microprocessors, Raymond M. Kline. Englewood Cliffs, NJ: Prentice-Hall, 1983; 464 pages, 18.5 by 24.3 cm, hardcover, ISBN 0-13-854554-5, $33.95.

The Theory of Relational Databases, David Maier. Rockville, MD: Computer Science Press, 1983; 656 pages, 16 by 23.5 cm, hardcover, ISBN 0-914894-42-0, $31.95.

Things To Do With Your Commodore 64 Computer, Jerry Willis, Merl Miller, and Deborrah Willis. New American Library, 1983; 192 pages, 10.5 by 17.8 cm, ISBN 0-451-12843-5, $3.95.

Things To Do With Your Commodore VIC 20, Jerry Willis, Merl Miller, and Deborrah Willis. New York: New American Library, 1983; 192 pages, 10.5 by 17.8 cm, softcover, ISBN 0-451-12844-3, $3.95.

Things To Do With Your TI-99/4A Computer, Jerry Willis, Merl Miller, and D. LaMont Johnson. New York: New American Library, 1983; 192 pages, 10.5 by 17.8 cm, softcover, ISBN 0-451-12842-7, $3.95.

Things To Do With Your TRS-80 Model 4 Computer, Jerry Willis, Merl Miller, and Cleborne D. Maddux. New York: New American Library, 1983; 224 pages, 10.5 by 17.8 cm, softcover, ISBN 0-451-12845-1, $3.95.

Timex/Sinclair Interfacing, James M. Downey and Don Rindsberg. Englewood Cliffs, NJ: Prentice-Hall, 1983; 160 pages, 15.3 by 22.8 cm, softcover, ISBN 0-13-921742-8, $10.95.

Transducers Theory & Applications, John A. Allocca and Allen Stuart. Reston, VA: Reston Publishing Co., 1984; 511 pages, 18 by 24 cm, hardcover, ISBN 0-8359-7796-X, $22.95.

A User-Friendly Guide to CP/M, James T. Perry and Robert F. McJunkins. Reston, VA: Reston Publishing Co., 1983; 240 pages, 14.8 by 23.8 cm, softcover, ISBN 0-8359-8117-7, $14.95.

VisiCalc Programming: No Experience Necessary, Shaffer & Shaffer Applied Research & Development Inc. Boston, MA: Little, Brown & Co., 1983; 258 pages, 19 by 23 cm, spiral-bound, ISBN 0-316-78235-1, $59.95. Includes floppy disk.

Winchester Disks in Microcomputers, Jonah McLeod. Oxford, England: Elsevier International Bulletins, 1983; 194 pages, 21 by 29.7 cm, softcover, ISBN 0-946395-07-1, $95.

Word Processing for Small Businesses, Steven F. Jong. Indianapolis, IN: Howard W. Sams & Co., 1983; 194 pages, 13.8 by 21.3 cm, softcover, ISBN 0-672-21929-8, $11.95.

Wordstar with Style, Roger B. White Jr. Reston, VA: Reston Publishing Co., 1983; 208 pages, 14.8 by 22.8 cm, spiral-bound, ISBN 0-8359-8793-0, $14.95.

The ZX81/TS1000 Home Computer Book, David C. Foyt. Berkeley, CA: Osborne/McGraw-Hill, 1983; 320 pages, 18.8 by 23.3 cm, softcover, ISBN 0-88134-106-1, $11.95. ■

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.

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Software Received

Apple

Ardy, an arcade-type game. Help Ardy the Aardvark search for food in an anthill without tying his tongue in knots. Beware of worms, stinging ants, and spiders that are attacking him. For every 10,000 points gained in one of eight increasingly difficult levels, Ardy wins another life. For the II Plus; floppy disk, $29.95. Datamost Inc., 8943 Fullbright Ave., Chatsworth, CA 91311-2750.

Baffles, an educational, interactive game that uses deductive reasoning and problem-solving skills. High school to college-level students in science and math learn systematic, economic procedures for formulating, testing, and confirming hypotheses consistent with observations made while playing this game. For II, IIe, and II Plus; floppy disk, $50. Conduit, POB 388, Iowa City, IA 52244.

BASIC*, an extension of Applesoft BASIC for engineers, scientists, and students. This program enhances BASIC with features that include high-resolution graphic commands for bit and area graphics, built-in programmable character sets for printing alphanumeric characters, and insertion and deletion of characters. It also has commands for screen viewing/switching and painting the screen to any given color. For II, II Plus, and IIe; floppy disk, $60. Softesmythe Software, 1000 West MacArthur #49, Santa Ana, CA 92707.

Biznes, a business-firm simulation program. Students can learn economic reasoning and theory in business by entering basic decisions about capital, labor, and price. Receive reports on what the business will produce, sell, and the profit, if any. Lessons include the law of diminishing returns, the equimarginal principle, elasticity, and marginal revenue. For II, II Plus, and IIe; floppy disk, $65. Conduit (see address above).

Bouncing Kamungas, an arcade-type game. As a melon farmer, you must skewer the Kamungas falling from the sky on your pitchfork so they don't ruin your melon crop. When the melons have ripened, rush them to market, avoiding Peronies on the road. If you hit one, all the melons that fall out of your truck will be devoured. For II, II Plus, and IIe; floppy disk, $19.95. Penguin Software, 830 4th Ave., POB 311, Geneva, IL 60134.

Cavern Creatures, an arcade-type maze game. Many people before you have failed to find the underground city. The caverns that are full of awful creatures stand in your way of success. And you must avoid the deadly wall surfaces. For II and II Plus; floppy disk, $29.95. Datamost Inc. (see address above).

Conquering Worlds, a strategic arcade-type game. The galaxy is on red alert and all civilizations are ready for war. As commander, you must capture planets, especially the pseudolife-robot successors of a once mighty but now extinct race. For the II Plus; floppy disk, $29.95. Datamost Inc. (see address above).

The Coveted Mirror, a medieval adventure game. The kingdom of Starbury is governed by an iron-fisted ruler, Voar the Vermin. He owns four of the five pieces of a magical mirror, once used to protect Starbury by the wizard, Munjistan. Find the last piece to break the power of Voar and save the kingdom. For II, II Plus, and IIe; floppy disk, $19.95. Penguin Software (see address above).

Crypt of Medea, a high-resolution adventure game. You are trapped in a crypt. By manipulating objects to solve logical puzzles, you make your way through the underground. Horrors await you, but musical tunes interspersed at key points lighten the burden. For II, II Plus, IIe, and III; floppy disk, $34.95. Sir-Tech Software Inc., 6 Main St., Ogdensburg, NY 13669.

Defender, an arcade-type game. Aliens are attacking your planet and you must use your best spaceship, *Defender*, to destroy them with smart bombs. Rescue the kidnapped humanoids before they are turned into killer mutants. With every fifth wave, ten humanoids are replaced. For II, II Plus, and IIe; floppy disk, $34.95. Atari Inc., POB 61657, Sunnyvale, CA 94086.

Eagles, an air-combat simulation. As a World War I pilot, battle with legendary pilots and aircraft, or assemble your own plane or squadron. As you fly in dogfights, you note altitude changes, flying techniques, ground location, and a situational overview. For II, II Plus, IIe, and III; floppy disk, $34.95. Strategic Simulations Inc., Building A-200, 883 Stierlin Rd., Mountain View, CA 94043-1983.

The Eating Machine, a nutritional-analysis program. You learn healthful diet management and meal planning, while the program calculates what and how many nutrients, vitamins, and calories you consume. For II Plus and IIe; floppy disk, $49.95. Muse Software, 347 North Charles St., Baltimore, MD 21201.

Fortress, a medieval strategy game for one or two players. Occupy and fortify your territory, then take over the surrounding countryside. The computer is an opponent that learns your strategy and uses it against you. For II Plus and IIe; floppy disk, $34.95. Strategic Simulations Inc. (see address above).

Four-Letter Words, four educational word games. Test high school or college-level students' knowledge of four-letter words using different combinations of letters. A dictionary of more than 3000 four-letter words includes plurals. You can use this program in the game mode or the inquiry mode. For II, II Plus, and IIe; floppy disks, $55. Conduit (see address above).

The Function Game, a mathematical educational program for seventh graders and above. Students explore the association between graphs of functions and their mathematical equations. Graphics, hints, scoring, and immediate performance feedback intensify home study. For II Plus and IIe; floppy disk, $39.95. Muse Software (see address above).

Infidel, the first in a series of interactive-prose adventure games. Stranded in the Egyptian desert with only a map, a cube with ancient markings, and an incomplete hieroglyphics dictionary, you must find the buried entrance to the last pyramid and seize priceless treasures that have been mysteriously

Software Received

hidden for ages. For the II; floppy disk, $49.95. Infocom, 55 Wheeler St., Cambridge, MA 02138.

Mark & Recapture, an educational biology program. Students learn three techniques for estimating field populations of highly mobile animals: the Lincoln-Peterson, Schnabel, and Schumacher-Eschmeyer models. A sample is removed and marked from a simulated population. When returned, counts provide ratios showing dispersal. Students must be able to perform simple calculations and algebraic manipulations. For II, II Plus, and IIe; floppy disk, $50. Conduit (see address above).

Mathdisk One, an educational program for use by high school and college-level students. The 43 programs let students invent and test random-number generators, input numbers that control graphics, and discover new prime-number-generating formulas. Includes workbook. For II Plus and IIe; floppy disk, $29.90. University of Evansville Press, Box 329B, Evansville, IN 47702.

Predation, an educational program for college-level ecology classes. Students study predator-prey interaction, explore theories, and solve equations. Two programs include Introduction to Predator-Prey Dynamics and Advanced Predation Models. Documentation includes user's notes and study questions for analysis techniques. For II, II Plus, and IIe; floppy disk, $50. Conduit (see address above).

Question and Answer, a teaching tool that aids in the presentation of test questions. A few types of questions are used: true and false, multiple choice, and fill in the blanks. The true and false option is the only one that does not allow a second try or give hints. For II Plus and IIe; floppy disk, $49.95. Bob Stalder, 3508 Furey Ave., Madison, WI 53714.

Speak Up!, a voice-synthesizer program that contains a text-to-speech algorithm for words and numbers. In order to convert words to speech, you must intentionally misspell words to meet their phonetic pronunciation. For II, II Plus, IIe, and III; floppy disk, $39.95. Classical Computing Inc., POB 3318, Chapel Hill, NC 27515.

Star Destroyer, an interstellar-war game. As the captain of the Star Destroyer *Beowulf*, you must defend the Federation fleet from attacking aliens by vaporizing their starships. Two-voice music accompanies you in your venture. Requires a joystick. For II Plus and IIe; floppy disk, $39.95. Harvest Time Software Co., POB 1527, Jacksonville, TX 75766.

Super Bunny, a graphic adventure game. Rabbitville is being attacked by wolves and snakes. Try to lead Reggie Rabbit to the magic carrots that turn him into Super Bunny. With five lives and other super qualities, he moves through various levels, pouncing on animals. Comic book included. For II and II Plus; floppy disk, $29.95. Datamost Inc. (see address above).

SX-48, a cross-assembler package that allows MCS-48 software development. The editor lets you create MCS-48 assembler source programs, and an assembler that assembles 8048 source programs and generates a program listing and the object code. For II Plus and IIe; floppy disk, $60. Allen Systems, 2151 Fairfax Rd., Columbus, OH 43221.

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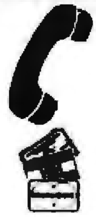

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TeloSchool, an administrative program for elementary schools. Keep track of almost 50 data items on each student, most of which you design. Eliminate repetitive typing by using standardized and customized reports and mailing labels. It also prints rosters and student profiles and tracks health problems, test scores, and participation in extracurricular activities. For II Plus and IIe; floppy disk, $549. Telos Software Products, 3420 Ocean Park Blvd., Santa Monica, CA 90405.

Three Mile Island, a nuclear power plant management simulation. You manage a reactor with the touch of a few keys controlling valves, pumps, filters, and turbines. Stay within the budget, repair equipment, update your schedule, and prevent radiation leaks, interruption of electricity production, and the ultimate meltdown. For II Plus and IIe; floppy disk, $39.95. Muse Software (see address above).

Tournament Golf, a golf-simulation program. Play golf from amateur to professional levels on two 18-hole courses. Graphics include fairways, greens, traps, and on-screen scoring. You practice on a driving range and putting green. But use strategy to avoid wind factors, woods, roughs, and water hazards. Up to four players can choose from 14 clubs displayed on the screen. For II, II Plus, and IIe; floppy disk, $30. The Avalon Hill Game Co., 4517 Harford Rd., Baltimore, MD 21214.

Work Force II, a business program for home or office. Features include checkbook balancing, a printing calculator, loan amortization, savings rates, wage analysis, and a correctable typewriter. Menu provides for updating data, change options, rerun programs, and printing of hard copies. For II, II Plus, and IIe; floppy disk, $29.95. Core Concepts, POB 24157, Tempe, AZ 85282.

Atari

Cohen's Towers, an arcade-type game. You have been hired by your uncle to deliver the mail in his corporation. Avoid the boss's dog and the Corporate Spy who steals mail. Kiss the secretary for points and rise through the levels with as few demerits as you can. Requires a joystick. For the 400/800; floppy disk, $29.95. Datamost Inc., 8943 Fullbright Ave., Chatsworth, CA 91311-2750.

Eagles, an air-combat simulation (see description under Apple). For 400/800 and 1200; floppy disk, $34.95. Strategic Simulations Inc., Building A-200, 883 Stierlin Rd., Mountain View, CA 94043-1983.

Easy, a machine-language programming teaching tool using BASIC-like statements. This program, for use with AMAC or MAC/65 macroassemblers, can be used by both beginner and advanced programmers. Features include interaction with hardware by providing operations such as player-missile graphics, input/output, and scrolling. For 400/800 and 1200; floppy disk, $39.95. Superware, 2028 Kingshouse Rd., Silver Spring, MD 20904.

Fortress, a medieval strategy game (see description under Apple). For 400/800 and 1200; floppy disk, $34.95. Strategic Simulations Inc. (see address above).

Mr. Robot and His Robot Factory, an arcade-type game. As Mr. Robot, you must collect all the power pills on one level before you can move on to one of the next 22 levels. Beware of obstacles such as moving treadmills, alien fire, energizers, and trampolines. Although you're given five lives, you get more if you can touch a life token. For the 400/800; floppy disk, $34.95. Datamost Inc. (see address above).

Panzer Jagd, two tactical-combat games. You are a World War II commander of almost 20 German tanks with limited fuel supply that must cross a terrain full of randomly generated ambush points. In Panzerun, you command 25 armored and infantry units in battle under similar conditions. For 400/800 and 1200; floppy disk, $30. The Avalon Hill Game Co., 4517 Harford Rd., Baltimore, MD 21214.

Smooth Writer, a word-processing package. Four programs provide extensive editing, the abilities to break up files too large for processing, format and print short or long text, and a horizontal scrolling feature that lets you access and select documentation before printing. For 400/800 and 1200; floppy disk, $79. Digital Deli, 3258 Forest Gale Dr., Forest Grove, OR 97116.

The Tail of Beta Lyrae, a high-resolution graphics game. Aliens have taken over your mining settlements. You must destroy their installations by traveling over a variety of terrains including mountains, natural and man-made caverns, and cities. For 400/800; floppy disk, $34.95. Datamost Inc. (see address above).

Ultima I, an adventure game. You have over 30,000 game days to travel through a mystical world consisting of monsters, oceans, grasslands, forests, mountains, towns, castles, landmarks, dungeons, and outer space. In the process, you must eliminate the evil Mondain who rules the world. For 400/800 and 1200; floppy disk, $39.95. Sierra On-Line Inc., Sierra On-Line Building, Coarsegold, CA 93614.

CP/M

ADS (Asset Depreciation System), a utility package for CP/M 2.2 operating systems designed to fulfill the requirement of tracking the cost of asset acquisition and subsequent depreciation, including straight line, declining balance, sum of the year's digits, and double-declining balance. It also prints reports and stores the entire depreciation schedule for any given schedule. Floppy disks, $64.95. Interactive Data Systems, 1409 B St., POB 2352, Marysville, CA 95901.

Dataplotter, a plotting package that prints publication-quality line graphs and scatterplots on dot-matrix printers. Features include a variety of symbols to represent points on graphs, an interactive program, and three utility programs that manipulate data files. Does not require a graphics terminal or programming experience. Floppy disk, $50. Lark Software, 7 Cedars Rd., Caldwell, NJ 07006.

Index, a utility package for CP/M 2.2 operating systems designed to index documents and document packages, briefs, reference material, and letters used in daily business transactions. This package is also capable of indexing a document either in keyword or key-phrase order

and in ascending or descending order. Floppy disk, $34.95. Interactive Data Systems (see address above).

UNREL, a disassembler package for relocatable files using CP/M 2.2 operating systems. You can decipher and modify relocatable files and handle files that have one or more program modules and can be preceded by an index as in IRL library files or in .REL files. Floppy disk, $45. John E. Calkins, 535 Barley Sheaf Rd., Coatesville, PA 19320.

Utility, a business-analysis package for CP/M 2.2 operating systems. Use it to reference the 150 financial, depreciation, and inventory-control formulas and functions and also for structured basic programming. The functions include source code in structured format that can be integrated into any number of user-defined programs. Floppy disks, $64.95. Interactive Data Systems (see address above).

Commodore

Bridge 64, a Bridge card-game simulation for novice and advanced players. Begin by learning the fundamentals of Bridge from the program. The computer will then take on the role of the challenger, with thousands of deals and bids available in high-resolution graphics. For the 64; cartridge, $39.95. Handic Software Inc., Suite 7, 5090 Central Highway, Pennsauken, NJ 08110.

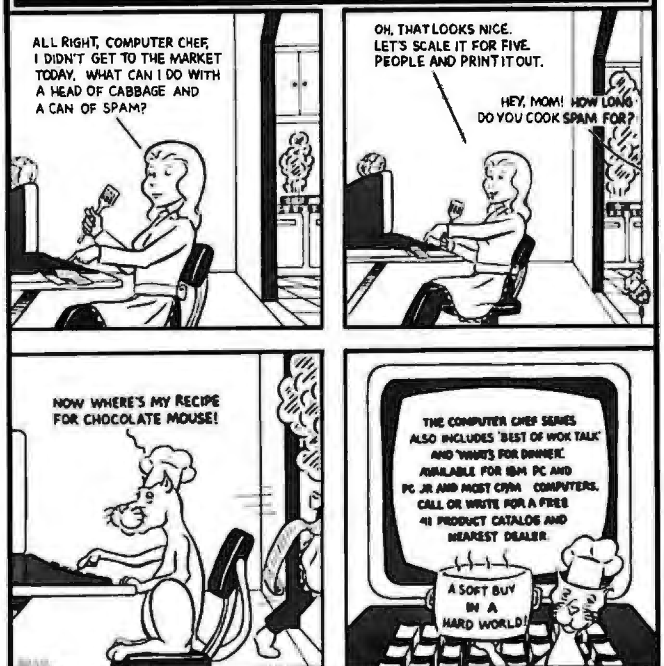
Calc Result, a spreadsheet program for business calculations or simulations. Features include three-dimensional split-screen capability, full-color for additional monitoring, bar-chart format, and protection of formulas. For the 64; cartridge and floppy disk, $79.95; advanced version on cartridge only, $194.95. Handic Software Inc. (see address above).

Crossfire, an arcade-type game. The aliens have landed, the city has been evacuated, and your regiment has retreated. Your only hope of survival is to destroy the aliens with your laser before they destroy you. Played on a grid screen, the object is not to get caught in the crossfire. For the 64; cassette, $29.95. Sierra On-Line Inc., Sierra On-Line Building, Coarsegold, CA 93614.

Diary 64, a database program that lets you keep track of phone numbers, addresses, appointments, birthdays, or any items that need to be remembered. For use both in business and at home, features include printout for address labels or a variety of other lists from the file. For the 64; cartridge, $29.95. Handic Software Inc. (see address above).

Forth 64, an operating system with a programming language for business applications and process-control environments. Features include a text editor, virtual memory, an interactive structured program environment, and functions in any numeric base. For the 64; cartridge, $39.95. Handic Software Inc. (see address above).

Graf 65, a high-resolution graphics package. Turn statistical information into graphic formats. A special routine for computing the integral of



Software Received

a function with a range you select. Functions can be defined and plotted within an x-axis range. For the 64; cartridge, $29.95. Handic Software Inc. (see address above).

Linear Programming System, a mathematical program. You can solve linear-programming problems with up to 50 variables and 35 constraints. Constraints can be less than, greater than, or equal to. All input is stored in a buffer, so you can change data in a revised problem. For the 64; cassette, $9.99. Computer Heroes, 1961 Dunn Rd., East Liverpool, OH 43920.

SAT English I, a test-preparation program. Useful for improving scores on the College Entrance Exams, this program lets you brush up on English skills including grammar, antonyms, analogies, reading comprehension, and sentence completion. The instruction mode is as helpful as the test mode. For the 64; floppy disk, $30. Micro Lab Inc., 2699 Skokie Valley Rd., Highland Park, IL 60035.

SAT Math I, a test-preparation program. To improve math scores on the College Entrance Exams, test and instruction modes provide how and why answers to your correct and incorrect responses. A few of the areas you'll strengthen include geometry, probabilities, square roots, ratios, and graphs. For the 64; floppy disk, $30. Micro Lab Inc. (see address above).

Stat 64, a statistical utility package. To simplify work with statistics and graphic displays, this program adds 19 commands to BASIC that include horizontal and vertical bar charts, statistical commands for calculations of mean value, standard deviation, and variance. For the 64; cartridge, $29.95. Handic Software Inc. (see address above).

Super Text, a display-oriented word-processing package. This system for school work, home record keeping, or business uses lets you write documents and easily change or update them without retyping the entire piece. Other features include printing, storing, and reviewing; 80-column display without additional hardware; and on-screen formatting. For the 64; floppy disk, $99. Muse Software, 347 North Charles St., Baltimore, MD 21201.

When I'm 64, a music-synthesizer system. In addition to the 15 preprogrammed songs, you can write your own songs, record them on disk, and play the computer keyboard like a synthesizer. Included in the program is an animated face that lets you see the lyrics of the songs. For the 64; floppy disk, $29.95. The Alien Group, 27 West 23rd St., New York, NY 10010.

IBM Personal Computer

Blast, a telecommunications program. You can transfer binary or text files to or from any other computer. Features include terminal-emulation facilities for accessing host computers; text-file uploading and downloading; and support for auto-dial/auto-answer modems. Floppy disk, $250. Communications Research Group Inc., 8939 Jefferson Highway, Baton Rouge, LA 70809.

Coherent, a program-development system written in C. This multiuser, multitasking

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system is compatible with Unix and provides powerful general-purpose tools for constructing and maintaining programs, as well as solving particular application problems. Floppy disk, $500. Mark Williams Company, 1430 West Wrightwood Ave., Chicago, IL 60614.

Colography, a color-graphics editor. You can create color-graphics images for business and sales presentations on screen. Programmers can write color-graphics programs. Features include the ability to duplicate, flip, move, paint, rotate, and scale the geometric patterns you create. Floppy disk, $99.95. Cactus Software Inc., POB 880, Peoria, AZ 85345.

Customizer, a utility program that helps you customize your Wordstar version 3.24 program by adjusting preset values or defaults to your specific editing parameters. These patches include adjustment of justified margins, top and bottom margins, single-spacing, page numbers, and more. You can always change them back to the original defaults. Floppy disk, $59.95. Computer Handholding, 1800 Market St. #91, San Francisco, CA 94102.

Disk Mechanic, a utility tool kit. You can analyze, preserve, repair, modify, and back up disks. The program can measure the rotation speed of any floppy-disk drive and control critical timing parameters such as drive-stepping rate and head-load time. Damaged portions of a disk can be read and copied. It also issues terse or detailed diagnostic reports. Floppy disk, $73. MLI Microsystems, POB 825, Framingham, MA 01701.

EpsLst, a listing program for printers. Designed for both business and home purposes, this program lets you compact printed information such as address files, source codes, telephone lists, and text for documentation into 12 columns across the page to include as many as 840 items. Saves lots of paper. Floppy disk, $18. On Disk Software, POB 382, Lincoln, MA 01773.

Health Risk Assessment, a statistical-analysis package. This program plots any individual's future life expectancy by amassing vital statistics such as personal habits, past and family medical histories, occupation, and other factors. Suggestions are then given for improving longevity through modification of personal health habits. Floppy disk, $59.50. Medmicro, POB 9615, Madison, WI 53715.

Innovative Mailing System, a mailing program for use both in business and at home. Features include adding and deleting names to and from files, changing existing records, and printing in alphabetical, mail-key, and numerical order. You can combine names and addresses with text to process form letters. Floppy disk, $36.75. Hi-Tech Services, POB 370, Dunkirk, MD 20754.

Matrix Master, a BASIC ROM extension package. You can call the standard matrix operations from BASIC subroutines. Features include abilities to add, subtract, multiply, transpose, inverse, identify, perform scalar arithmetic operations, and set matrix to a constant. Two load files are available and chained through an executive. Floppy disk, $34.95. PAB Software Inc., POB 15397, Ft. Wayne, IN 46885.

Next Step, an applications-generator package. This business package lets you design

a custom package to your own specifications in a four-part process without knowing how to program. You create the database, enter information into the application, and create and run reports. Floppy disk, $345. Execuware, 7415 Pineville-Matthews Rd., Suite 300, Box 10, Intercontinental Plaza, Charlotte, NC 28211.

Pac-Man, an arcade game. Fashioned after the video game, you try to consume as many dots as possible while avoiding goblins. Munch an energy dot and you can eat everything in sight, including the goblins. Win extra bonus points by eating the flashing dots. Floppy disk, $34.95. Atari Inc., 1265 Borregas Ave., POB 427, Sunnyvale, CA 94086.

Personal Cobol, a utility package consisting of programs that provide powerful and easy-to-use facilities for creating, testing, and running sophisticated business programs written in full ANSI '74 Level II COBOL. Floppy disks, $399. Micro Focus, Suite 400, 2465 East Bayshore Rd., Palo Alto, CA 94303.

Prolock, a copy-protection system. You can copy-protect individual files or an entire disk. The program marks files and only an operator who has the Prolock disk can use the marked software. The protection is invisible to the user. Bit or nibble copiers are rendered ineffective. Floppy disk, $9.95. Vault Corp., Suite 500, 2649 Townsgate Rd., Westlake, CA 91361.

Rattenmund, a logical adventure game in which you use complete sentences in plain English to try to escape from the city. Solve the puzzles, recognize opportunity, and avoid the elements while you struggle with vicious rats, poisonous snakes, a lecherous doctor, and a neurotic but heroic cat. Floppy disk, $39.95. Wallace Associates, 934 Hunter Rd., Wilmette, IL 60091.

Robotron: 2084, an arcade-type game. It is the year 2084, and a robot revolt is going on. You are the only one that can defend humanity by resisting their mutant reprogramming. Beware of the grunts, brains, tanks, sheroids, electrodes, and especially the Hulk, who is immune to your laser. Floppy disk, $34.95. Atari Inc. (see address above).

Salestaxfile, a business-indexing program that maintains sales-tax information and includes a 235-location sales-tax file. Features include a comprehensive file maintenance to add, change, and delete locations; file printouts and displays in a variety of formats; and backup and recovery. Floppy disk, $125. RJL Systems, 106 New Haven Ave., Milford, CT 06460.

Screen Saver, a collection of preventive-maintenance and protection programs. For use in protecting your screen from phosphor burnout, one program will turn your screen off automatically after a period of inactivity. It operates independently of application programs and operating systems. Other programs include a disk timer, memory test, disk-drive and disk tester, and a drive-cleaning utility. Floppy disk, $19.95. Logical Systems Corp., Route 1, Box 253, St. Michael, MN 55376.

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Scrollmate, a screen-display utility. The program creates a buffer in memory that can hold up to 14 screens on line The screens or lines can be scrolled up or down with DOS commands or your own programs. Screens can be called to provide a window on display memory or printed. Floppy disk, $69.95. Inner Loop Software, Suite 120, 5456 McConnell Ave., Los Angeles, CA 90066.

Softmaker II, a Microsoft BASIC program-generator package. This program lets you write BASIC database programs without previous programming experience. The modular, compact programs are easily modifiable and save program memory by using as little disk space as possible. Floppy disk, $89.95. Rio Grande Software, 705 North Calhoun, POB 77, West Liberty, IA 52776.

Star Fleet I, a space-battle strategy game. You are an officer of Star Fleet. Work your way up to Admiral by defeating the Krellan and Zaldron invaders. As your abilities improve, you automatically receive more challenging missions and are awarded decorations for outstanding performances. Floppy disk, $49.95. Cygnus, POB 57825, Webster, TX 77598.

Tax Relief II, a business-tax preparation package. This program helps you calculate taxes using 24 schedules and forms and automatically selects the most advantageous method. Features include tax calculations, carryovers, data-entry editing, reviewing, printing returns, batch printing, and updates. Floppy disk, $299. Micro Vision, 145 Wicks Rd., Commack, NY 11725.

Ultima II, a fantasy role-playing game. In this sequel, you avoid the revenge of Minax, the enchantress of evil. In so doing, create your own characters with varying amounts of such attributes as strength, agility, stamina, charisma, wisdom, and intelligence. Cast spells, explore dungeons, seize ships, and meet Lord British. Floppy disks, $59.95. Sierra On-Line Inc., Sierra On-Line Building, Coarsegold, CA 93614.

Ultrafile, a database-management package for home and business uses. With little or no computer experience, you can retrieve, calculate, display, report, and make many kinds of graphs using the three programs for filing, reporting, and graphics. Floppy disks, $195. Continental Software, 11223 South Hindry Ave., Los Angeles, CA 90045.

Wordvision, a word-processing program. You can create, revise, store, format, and print text for a variety of needs. Features include instant response, separate control panels, an indexed guide, and customized key labels or slip-on keytops for quick reference. Floppy disk, $79.95. Bruce & James Program Publishers Inc., The Wharfside Building, Suite 357, 680 Beach St., San Francisco, CA 94109.

Word Wiggle, an educational word game. This program pits you against the computer in a race against time to see who can find the most words in a four-by-four grid of letters. Eleven skill levels and a 30,000-word dictionary develop vocabulary skills. Floppy disk, $29.95. The Software Toolworks, Suite 1118, 15233 Ventura Blvd., Sherman Oaks, CA 91403.

Other Computers

Armer Balloon, an arcade-type game. The year is 3249 and aliens are attacking you again. Earlier you eluded their fire, but now the defense shield barriers are broken by their armor dirigibles resembling balloons. Destroy the balloons before they destroy you. For the Toshiba T-100; floppy disk, $34.95. J.W. Computers, 2655 West Guadalupe Rd. #7, Mesa, AZ 85202.

Decision Maker, an evaluation program for making informed decisions. For business and home uses, this program uses analytical procedures while you state the problem, list the alternatives, and weigh the options. You get an optimum solution based on your input. For the TRS-80 Color Computer; cassette, $24.95. Armadillo International Software, POB 7661, Austin, TX 78712.

Firefly.Com, a puzzle game. Collect as many fireflies as you can and place them in the jar. With their flickering light, solve clues at the bottom of the jar to guess the quote. Capture all 20 fireflies and the quote appears. For the Heath/Zenith H-/Z-89; floppy disk, $20. Friendliware, POB 21206, Lansing, MI 48909.

Shamus, an arcade-type game. As Shamus, you must reach the core of the Shadow's lair and destroy him. Explore four floors, each with 32 rooms, destroying guards along the way to defend your life. For the Texas Instruments TI 99/4A; ROM cartridge, $44.95. Atari Inc., 1265 Borregas Ave., POB 427, Sunnyvale, CA 94086.■

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.

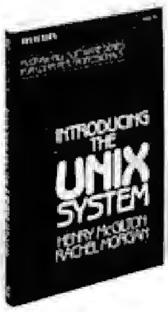
BYTE's Bits

Master's in Computer Education Program

A program leading to a Master's degree in computer education and training has been announced by Trinity College. This 33-credit program has three areas of emphasis: technical competency, planning for computer use in learning environments, and designing computer-based curricula and learning materials.

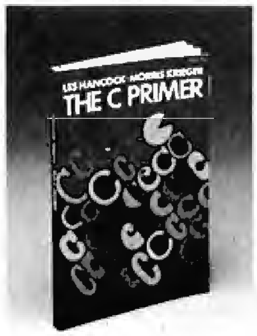
For more information, contact Deborah Blank, Education Department, Trinity College, Michigan & Franklin Ave. NE, Washington, DC 20017, (202) 269-2374.■

Ciarcia's Circuit Cellar—Volume IV
by Steve Ciarcia. A new slew of buildable electronic projects from this famous workshop. Includes an interactive video disc controller, the Microvox text-to-speech synthesizer, an IMB compatible computer, and more!
#010966-4 256 pp. $18.95



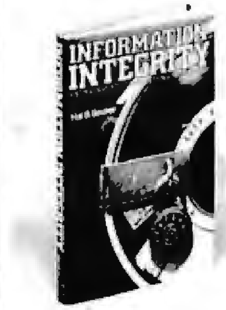
Introducing the UNIX System
by Henry McGilton and Rachel Morgan. Gets you over hurdles and hazards as it unscrambles the documentation for this powerful new tool and leads you to a perfect understanding of how best to use its remarkable features.
#045001-3 576 pp. $18.95

Guide to the IBM Personal Computer
by Walter Sikonowiz. Goes beyond the manuals to help you exploit the full power of your IBM PC. Features DOS 2.0 and BASIC 2.0, and includes details on the new system architecture and expansion capabilities.
#057484-7 352 pp. $19.95



The C Primer
by Les Hancock and Morris Kreiger. Provides hands-on experience that enables both old hands and "C" novices to write better programs in the language of UNIX. "Clear and succinct . . . a book that really works." — *Personal Computing*
#025981-x 256 pp. $14.95

Other new titles from McGraw-Hill



Information Integrity: A Structure for Its Definition and Management
by Hal B. Becker. How vulnerable is your electronically stored business information to accidental loss or alteration, or deliberate fraud or theft? Here's how to recognize risks and head off dangers.
#004191-1 256 pp. $26.95

A Programmer's View of the Intel 432 System
by Elliott I. Organick. All about using the revolutionary new advance in computer architecture — the iAPX 432 "mainframe on a micro" chip — for all those programming in Ada or Pascal.
#047719-1 352 pp. $24.95

— New and also available from McGraw-Hill — these authoritative Datapro/McGraw-Hill *guides*

APPLE SOFTWARE	#015403-1	256 pp.	$19.95
IBM PC SOFTWARE	#015424-4	256 pp.	$19.95
CP/M SOFTWARE	#015404-X	256 pp.	$19.95

Latest in the ever-popular, ever-helpful WEBSTER BUYER'S GUIDE series...

Software Buyer's Guide
Selecting microcomputer software could be your Waterloo without these facts about today's 50 top-selling programs for spreadsheets, word processors, data base managers, communications packages, and integrated packages.
#068967-9 352 pp. $19.95

Terminals and Printers Buyer's Guide
You've chosen your computer — now simplify the search for other hardware options. Here's what you should know to find the right price/performance trade-off among 150 major products to upgrade your system.
#068968-7 320 pp. $19.95

Microcomputer Buyer's Guide, 3rd Ed.
To help you make sense of 500 available products — hardware, software, peripherals — here are full, in-depth details. The machines covered even include the latest — the Coleco Adam, the IBM PCjr, and the Macintosh from Apple.
#068963-6 384 pp. $19.95

Office Automation & Word Processing Buyer's Guide
Direct comparisons of features and potentials, to help you choose the right system for every size business or special need — from electronic typewriters to communications networks.
#068962-8 320 pp. $19.95

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Event Queue

April 1984

April
Continuing Engineering Education Courses, Washington, DC, Orlando, FL, and San Diego, CA. More than 300 courses for practicing computer and information-processing professionals are offered by George Washington University. A few of the titles include "Mathematical Software for Scientific and Engineering Applications," "An Applications-oriented Approach to Artificial Intelligence," and "Minicomputers, Microcomputers/Processors for Nonelectrical Engineers." Fees range from $625 to $875. Contact Continuing Engineering Education, School of Engineering and Applied Science, George Washington University, Washington, DC 20052, (800) 424-9773; in the District of Columbia, (202) 676-8522.

April
Courses in C Language and Unix, various sites throughout the U.S. Three five-day courses are offered: "C Programming Workshop," "Advanced C Topics Seminar," and "Unix Workshop." For complete details, contact Joan Hall, Plum Hall Inc., 1 Spruce Ave., Cardiff, NJ 08232, (609) 927-3770.

April–June
Productivity '84, various sites throughout the U.S. This series of two-day programs serves as a showcase of Hewlett-Packard products. Seminars are available, and more than 25 products are to be demonstrated, including the HP 150 personal computer and laser printers. Admission is free. For more information, contact Hewlett-Packard, Public Relations Department, 3000 Hanover St., Palo Alto, CA 94304, (800) 554-4466.

April–June
Seminars from the Continuing Education Institute, various sites throughout the U.S. Among the seminars offered are "Correlation and Spectral Analysis for Engineering and Scientific Applications," "Database Machines: An Overview," and "Peripheral Array Processors." For complete information, contact Continuing Education Institute, Oliver's Carriage House, 5410 Leaf Treader Way, Columbia, MD 21044, (301) 596-0111; in California, (213) 824-9545.

April–June
Seminars from Datapro Research Corporation, various sites throughout the U.S. Subject areas include data communications, microcomputers, and information systems. In-house presentations of technical programs can be arranged. For a 40-page catalog of seminars, contact Datapro Research Corp., 1805 Underwood Blvd., Delran, NJ 08075, (800) 257-9406; in New Jersey, (609) 764-0100.

April–June
Understanding Microprocessor-based Equipment and Troubleshooting, various sites throughout the U.S. This comprehensive four-day seminar provides a background in microprocessor fundamentals and troubleshooting techniques for technicians and engineers. Equipment familiarization and hands-on experimentation are emphasized. On-site presentations can be arranged. For information, contact the Registrar, Micro Systems Institute, Garnett, KS 66032, (913) 898-6152.

April–July
Reliability and Maintainability Engineering Institutes and Short Courses, various sites throughout the U.S. A few of the programs to be offered are "Reliability Engineering, Testing, and Maintainability Engineering" and "Mechanical Reliability and Probabilistic Design for Reliability—The Stress/Strength Interference Approach to Designing a Desired Reliability into Components and Equipment." For a complete schedule, contact Dr. Dimitri Kececioglu, College of Engineering, Aerospace and Mechanical Engineering Department, University of Arizona, Tucson, AZ 85721, (602) 621-2495.

April–August
Compuworkshops Computer Seminars for Educators, various locations throughout California. Among the seminars offered are "Authoring Tools and Word Processing for Educators," "BASIC Programming for Educators," "Designing Educational Courseware," "Computer Literacy for Educators," and "How to Set up a Computer-based Education Program in Your School or District." The fee is $50 per course. For details, contact Compukids of Seal Beach, Rossmoor Shopping Center, 12385 Seal Beach Blvd., Seal Beach, CA 90740, (213) 430-7226; West Los Angeles, (213) 473-8002; Tarzana, (213) 343-4008; Rancho Bernardo/San Diego, (619) 451-1742.

April–August
Conferences and Expositions from the Society of Manufacturing Engineers, various sites throughout the U.S. and around the world. More than 25 conferences and expositions are scheduled. For a calendar, contact the Public Relations Department, Society of Manufacturing Engineers, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-0777.

April–September
Computer Competence Seminars, Boston University Metropolitan College, Boston, MA. This series of hands-on presentations is tailored for managers who know little or nothing about computers and for those who wish to sharpen current skills. Some of the seminars on the docket are "The Complete Beginners Guide to Personal Computers," "PCs for Improving Financial Analysis and Decision Support," and "Personal Computers for Sales and Marketing Professionals." Fees range from $225 to $595. In-house programs can be organized. For details, contact Joan Merrick, University Seminar Center, Suite 415, 850 Boylston St., Chestnut Hill, MA 02167, (617) 738-5020.

April–October
Tutorial Short Courses from Hellman Associates, various sites throughout the U.S. Among the courses offered are "VLSI Design," "Digital Control," and "Error Correction." Fees are generally $895. For a descriptive brochure, contact Hellman Associates Inc., Suite 300, 299 California Ave., Palo Alto, CA 94306, (415) 328-4091.

April 10–11
Business Expo & Conference '84, Convention Center, San Jose, CA. A few of the more than 30 workshops, seminars, and panel discussions that have been scheduled include presentations entitled "Handling Training Crisis in Office Automation Explosion," "How to Select Small Business Computers," and

"Managing Your Small Business." Complete details are available from Expo '84 Management, Cartlidge & Associates Inc., Suite 205, 4030 Moorpark Ave., San Jose, CA 95117, (408) 554-6644.

April 11-12
Global Teleconferencing Symposium, Hilton Hotel, Washington, DC. This program is designed to provide teleconferencing information to top-level decision makers from government agencies and private industries. Issues include federal-telecommunications policy trends, human factors in the teleconferencing process, and training systems users. An exposition of products and services will run concurrently. For information, contact National Trade Productions Inc., 9418 Annapolis Rd., Lanham, MD 20706, (800) 638-8510; in Maryland, (301) 459-8383.

April 12-14
Carolina Computer Show, Civic Center, Charlotte, NC. Manufacturers, distributors, and retailers will display hardware, software, accessories, and services. Address inquiries to L & J Associates Inc., POB 53729, Fayetteville, NC 28305, (919) 323-4713.

April 12-14
Computers and Writing—Research and Applications, University of Minnesota, Minneapolis. Papers and panel discussions will focus on local-area networks and empirical studies of writer's behavior. Demonstrations of hardware and software are planned. For further information, contact the Program in Composition and Communication, University of Minnesota, 209 Lind Hall, 207 Church St. SE, Minneapolis, MN 55455, (612) 373-2541.

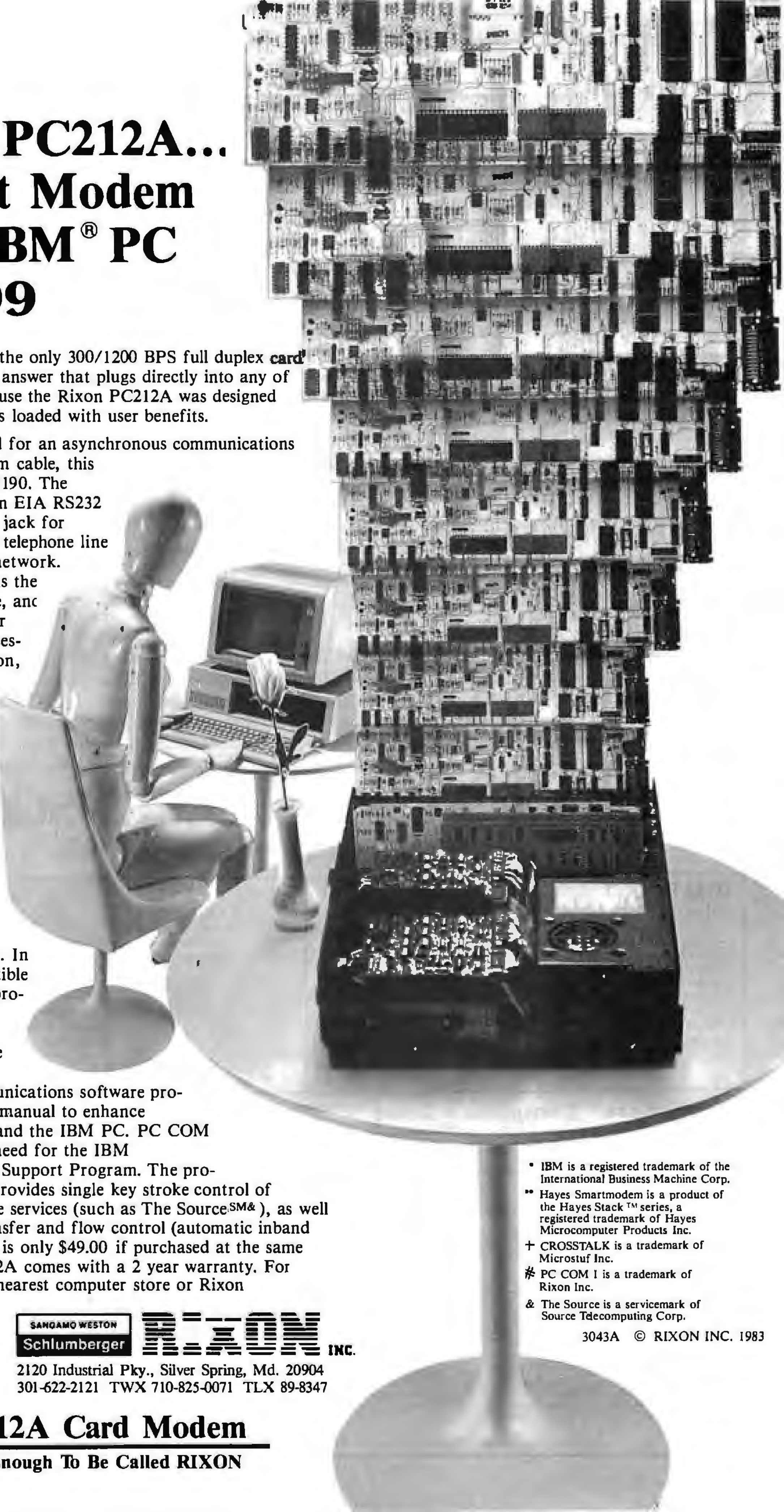
April 12-15
Computer and Communication Expo, Convention Hall Exposition Complex, Asbury Park, NJ. Contact Tom Gasque, Computer and Communication Expo, Cerex Marketing, Convention Hall, Asbury Park, NJ 07712.

April 12-15
The Third Annual St. Louis Computer Showcase Expo, A. J. Cervantes Convention Center, St. Louis, MO. More than 100 national and local vendors will exhibit computers, word-processing equipment, associated peripherals, software, and services. Elementary and advanced seminars will be available. Admission is $7.50. For details, contact The Interface Group Inc., 300 First Ave., Needham, MA 02194, (800) 325-3330; in Massachusetts, (617) 449-6600.

April 13-14
The Fourteenth Annual Virginia Computer User's Conference—VCUC-14, Sheraton Hotel, Blacksburg, VA. This conference is sponsored by the Virginia Tech Student Chapter of the Association for Computing Machinery and the computer science department of Virginia Tech. Topics include modeling and simulation, STARS and Japanese fifth-generation computers, and microcomputers. For information, contact Suzanne Nagy or Roger Goff, VCUC-14, 562 McBryde Hall, Virginia Tech, Blacksburg, VA 24061.

April 13-15
The International Personal Robotics Congress and Exposition 1984—IPRC '84, Convention Center, Albuquerque, NM. International corporations and high-technology executives can view

The Rixon PC212A... The Perfect Modem For Your IBM® PC ...Only $499



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April 13–15
Interstellar Personal Computer Show, Interstate Fairgrounds, Spokane, WA. For details, contact Heymac Promotions, East 3607 33rd, Spokane, WA 99203, (509) 534-3661 (mornings) or (509) 327-4842 (afternoons).

April 13–15
Microcomputers and Basic Skills in College, Instructional Resource Center, City University of New York, NY. Papers will explore the use of microcomputers in post-secondary school basic-skills instruction, including English as a second language, reading, writing, and speech. Address inquiries to Geoffrey Akst, Conference Chair, Instructional Resource Center, City University of New York, 535 East 80th St., New York, NY 10021, (212) 794-5425.

April 14
Third Semi-annual Meeting of the Massachusetts Association of Computer-using Educators, Simmons College, Boston, MA. This meeting will feature demonstrations on the uses of computers in the classroom. Contact Dr. Leonard Huber, Hampshire Educational Collaborative, Center School, 36 Hadley St., South Hadley, MA 01075, (413) 534-4563.

April 14–15
The Ninth Annual Trenton Computer Festival, Trenton State College, NJ. More than 100 commercial exhibitors and five acres of flea-market tables will be featured at this annual spring event. Contact Marilyn Hughes, Trenton State College, Trenton, NJ 08625, (609) 771-2487.

April 15
Maryland Computer Meet, Armory, Silver Spring, MD. The opportunity to buy, sell, or trade hardware and software is combined with computer demonstrations. For details, contact Capitol Computer Group, 308 Main St., POB 5210, Laurel, MD 20707, (301) 498-0121.

April 16–18
Softside of Software, Loew's L'Enfant Plaza Hotel, Washington, DC. Examining the many facets of writing user-friendly software and documentation, this seminar focuses on documentation techniques, standards, software engineering tools, and designing on-line helps. User and customer training are also addressed. The cost for all three days is $595. For registration details, contact Cross Information Co., Suite B, 934 Pearl Mall, Boulder, CO 80302-5181, (303) 499-8888.

April 16–18
Videotex '84, Chicago, IL. The focus of this international conference and exhibition is commercial applications and activities of videotex. For details, contact Sally Summers, London Online Inc., Suite 1190, 2 Penn Plaza, New York, NY 10121, (212) 279-8890.

April 17–18
The Second Annual Broadband Local Networks Forum, Hyatt Regency Crystal City, Washington, DC. This forum brings together manufacturers and users of broadband local networks to ex-

change views and information in an informal setting. The agenda includes an optional tutorial on recent developments in local-network technology, manufacturer presentations, and panel discussions. The cost is $395. The optional tutorial, held on April 16, is $125. For more information, contact Architecture Technology Corp., POB 24344, Minneapolis, MN 55424, (612) 935-2035.

April 17–19

IPAD II, Marriott Hotel, Denver, CO. This is the second national symposium designed to promote a wider awareness of the technology surrounding the Integrated Program for Aerospace-vehicle Design (IPAD). The focus will be on advances in distributed database-management technology to support integrated CAD/CAM requirements. It is sponsored by the National Aeronautics and Space Administration, the Department of the Navy, and the Industry Technical Advisory Board for IPAD. Information is available from the IPAD Project Office, Mail Stop 246, NASA Langley Research Center, Hampton, VA 23665, (804) 865-2888.

April 18–19

Minnesota Office Systems Association Symposium and Exhibition, Hyatt Regency, Minneapolis, MN. Speakers, more than 100 exhibits, and 21 seminars will highlight this eleventh anniversary event focusing on "Evolving Technologies." Further information is available from the Minnesota Office Systems Association, POB 2144, Loop Station, Minneapolis, MN 55402-0144, (612) 293-1395.

April 18–20

The 1984 Rocky Mountain Data Processing Expo & Conference, Denver, CO. This is the seventh annual exposition sponsored by the Mile High Chapter of the Data Processing Management Association. Displays will include mini- and microcomputers, word processors, software, educational services, and network systems. It is being held in conjunction with the DPMA's Region 4 conference. For information, contact Industrial Presentations West Inc., Suite 304, 3090 South Jamaica Court, Aurora, CO 80014, (303) 696-6100.

April 23–27

Auditing in the Contemporary Computer Environment, Philadelphia, PA. Participants will learn a comprehensive audit approach for computer-based systems. Topics include how to evaluate controls, how to prepare an audit report, and how to design a program of tests using questionnaires, checklists, software tools, and flowcharts. Contact the EDP Auditors Foundation, 373 South Schmale Rd., Carol Stream, IL 60187, (312) 682-1200.

April 26–29

The Second Annual San Diego Computer Showcase Expo, Convention and Performing Arts Center, San Diego, CA. More than 100 national and local vendors will exhibit small computers, word-processing equipment, associated peripherals, software, and services. Elementary and advanced seminars will be available. For more information, contact The Interface Group Inc., 300 First Ave., Needham, MA 02194, (800) 325-3330; in Massachusetts, (617) 449-6600.

April 26–28

Science Park '84, New Haven, CT. This microcomputer conference and exposition is designed for small-business executives. For details, contact Science Park '84, Five Science Park, New Haven, CT 06511, (203) 436-3089.

April 27
How to Document a Computer System, Holiday Inn-Central, Tampa, FL. This seminar presents a series of procedures that covers the system-development process, including project initiation, study, design, programming, implementation, and maintenance. The fee is $155. Contact Technical Communications Associates, Suite 210, 1250 Oakmead Parkway, Sunnyvale, CA 94086, (800) 227-3800, ext. 977; in California, (408) 737-2665.

April 30
How to Document a Computer System, Sheraton-Emory Inn, Atlanta, GA. For details, see April 27.

April 30–May 2
Printed Circuit Fabrication, Sheraton Harbor Island West Hotel, San Diego, CA. The theme for this technical seminar, sponsored by PMS Industries, is "Building in Quality." It is designed as a problem-solving forum for the manufacturers of printed-circuit boards. Addresses by industry leaders and discussions on process-technology are on the agenda. The cost for the three-day session is $350. Further information is available from Laura Harrel, PMS Industries, 625 Sims Industrial, Alpharetta, GA 30201, (404) 475-1818.

May 1984

May–July
Courses from Integrated Computer Systems, various sites throughout the U.S. Among the courses to be presented are "Designing with 16-bit Micros," "Programming in C: A Hands-on Workshop," and "Hands-on Unix Workshop." The fee for each course is $895. Enrollment details are available from Ruth Dordick, Integrated Computer Systems, 6305 Arizona Place, POB 45405, Los Angeles, CA 90045, (213) 417-8888.

May 1–3
Electronic Production Efficiency Exposition, National Exhibition Centre, Birmingham, England. This exhibition brings together various organizations involved in producing hardware and software for automated factories. Technical sessions will cover such issues as computer-aided design and manufacturing, integration, test diagnosis and repair strategies, and electronic-manufacturing assembly techniques. Contact Network Events Ltd., Printers Mews, Market Hill, Buckingham, MK18 1JX, UK; tel: (0280) 815226; Telex: 83111.

May 2–3
Networking Personal Computers, Halloran House, New York, NY. For details, contact Ginny Kania, Frost & Sullivan, 106 Fulton St., New York, NY 10038, (212) 233-1080.

May 3–6
Personal Computer Userfest/Chicago, O'Hare Exposition Center, Rosemont, IL. Apple, IBM, and compatible computers, software, and accessories will be featured. Information is available from Northeast Expositions, 822 Boylston St., Chestnut Hill, MA 02167, (617) 739-2000.

May 5
The Sixth Annual Computer Conference for Educators, Lesley College, Cambridge,

MA. Panel discussions, more than 20 presentations, and sessions that include hands-on workshops on software in science, social science, language arts, and math will be offered. Additional information is available from Susan Friel or Nancy Roberts, Lesley College, 29 Everett St., Cambridge, MA 02238, (617) 868-9600.

May 6-9
Comunicaciones Expo '84, Curtis Hixon Hall, Tampa, FL. For details, contact Mitch Hall Associates, POB 860, Westwood, MA 02090, (617) 329-8090.

May 6-11
International Communications Association, Las Vegas, NV. This is the thirty-seventh annual conference and exposition. For details, contact ICA Headquarters, Suite 828, LB-89, 12750 Merit Dr., Dallas, TX 75251, (214) 233-3889.

May 7-9
EDP Audit, Controls, and Security Symposium, Woodfield Hyatt House, Woodfield, IL. This symposium offers seminars, workshops, and exhibits relating to the state of the art in electronic-data-processing (EDP) auditing. Address inquiries to EDP Audit Associates Inc., POB 255, Chicago Ridge, IL 60415, (312) 364-4624.

May 7-11
Fiber and Integrated Optics, Ottawa, Ontario, Canada. This short course explores such fiber-optic components as single- and multimode fiber cabling, photo detectors, receiver and repeater technology, and optical fiber sensors. The fee is $875. For details, contact Continuing Engineering Education, George Washington University, Washington, DC 20052, (800) 424-9773; in the District of Columbia, (202) 676-6106.

May 7-11
Tutorials for Professional Development, Marriott O'Hare, Chicago, IL. Two tracks, "Software Engineering" and "Networks and Communications," compose this program sponsored by the IEEE Computer Society and the Association for Computing Machinery. For a copy of the program, contact Tutorials for Professional Development, POB 639, Silver Spring, MD 20901, (301) 589-8142.

May 9-11
Session 84, Calgary, Alberta, Canada. The theme of this annual national conference of the Canadian Information Processing Society is "1984: Images of Fear, Images of Hope." Parallel seminars, panel discussions, technical papers, and exhibits of hardware, software, and services will assist in the exchange of views between users and suppliers. Conference information can be obtained from Ms. Marilyn Harris, Suite 722, Suncor Tower, 500 4th Ave. SW, Calgary, Alberta T2P 2V6, Canada, (403) 261-5903.

May 10-12
BYTE Computer Show, McCormick Place, Chicago, IL. Seminars, product displays, and conference sessions are some of the highlights of this show sponsored by BYTE and *Popular Computing* magazines. For complete details, contact The Interface Group Inc., 300 First Ave., Needham, MA 02194, (800) 325-3330; in Massachusetts, (617) 449-6600.

Event Queue

May 11
Writing Efficient Programs, Mathematics and Science Building, Room W-117, Montclair State College, Upper Montclair, NJ. Dr. Jon Bentley from Bell Laboratories will speak on writing machine-independent code. He will present a general set of rules for using this tool and show how those rules can speed up a program. A subtheme will address the problem of converting programming tricks into engineering techniques. For information, contact Gideon Nettler, Department of Mathematics and Computer Science, Montclair State College, Upper Montclair, NJ 07043, (201) 893-4294.

May 12–14
Softwest '84, Regency Hotel and Conference Center, Denver, CO. This conference and exhibition features seminars, lectures, and panel discussions on software, equipment, and peripherals for Apple and IBM computers. For information, contact Colorado Conference Group, Suite C, 3312 Cripple Creek, Boulder, CO 80303, (303) 499-1034.

May 13–17
Computer Graphics '84, Convention Center, Anaheim, CA. Panel discussions on specific standards, technical sessions exploring the application of standards in a working environment, and tutorials explaining standards will be complemented by an exposition. For details, contact the National Computer Graphics Association, Department ZF, Suite 601, 8401 Arlington Blvd., Fairfax, VA 22031, (703) 698-9600.

May 14–16
Annual Conference of ADCIS, Ohio State University, Columbus. This annual conference is sponsored by the Association for the Development of Computer-based Instructional Systems (ADCIS). Papers and demonstrations of hardware, software, and courseware will emphasize portability. For details, contact ADCIS International Headquarters, 409 Miller Hall, Western Washington University, Bellingham, WA 98225, (206) 676-2860.

May 15–17
Criminal Justice Systems Conference, Virginia Commonwealth University, Richmond, VA. Presentations and panel discussions on recent developments in criminal justice applications of computer technology are planned. Additional sessions will address the uses of microcomputers in law enforcement. The fee is $20. Information is available from Ben Wood, Department of Criminal Justice Services, 805 East Broad St., Richmond, VA 23219, (804) 786-4000.

May 15–17
Electro/84 and **Mini/Micro Northeast/84,** Boston, MA. Conference sessions will address a broad range of topics, including artificial intelligence, communications and networks, distributed systems, microprocessor technology, and robotics. For details, contact the producer of this program, Electronic Conventions Inc., 8110 Airport Blvd., Los Angeles, CA 90045, (213) 772-2965.

May 15–17
Micro City '84, Exhibition Complex, Bristol, England. More than 100 companies will exhibit computers, business systems, and communications equipment. For complete details, contact Tomorrow's World Exhibitions Ltd., 9 Park Place, Clifton, Bristol BS8 1JP, UK; tel: (0272) 292156/7.

May 16–18
Teaching Math with Microcomputers, Marriott Hotel,

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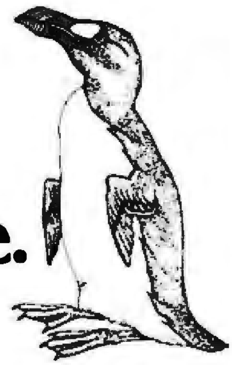

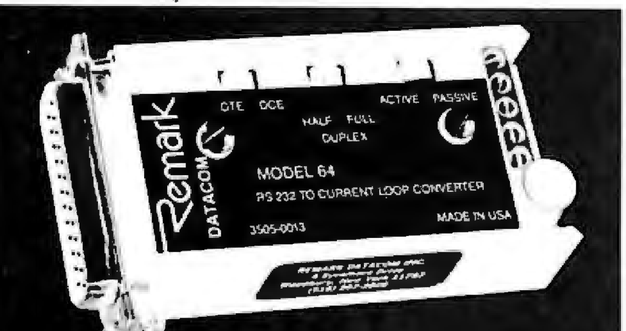

Miami, FL. This program, sponsored by the National Council of Teachers of Mathematics (NCTM), is designed to inform elementary, intermediate, and secondary school mathematics teachers how to effectively use the microcomputer as a classroom tool. For further information, contact NCTM, 1906 Association Dr., Reston, VA 22091, (703) 620-9840.

May 19
The Seventh Annual Show & Tell Microcomputer Conference, University of Oklahoma Mathematics and Physical Science Complex, Norman, OK. Computer hobbyists are invited to speak briefly, demonstrate an example of their presentation, and answer questions. For details, send a self-addressed, stamped envelope to Show & Tell, Dr. Richard Andree, University of Oklahoma, Mathematics Department, 601 Elm St., Norman, OK 73019.

May 20-23
The Fourth Annual Conference of the Association of Human Resource Systems Professionals, Hyatt Regency, Fort Worth, TX. Roundtable discussions will address topics related to the theme for this conference, "People, Data, and Systems . . . Putting It All Together." This includes cross-disciplinary concerns and the practical requirements of successful human-resource information-system development as well as networking, vendor evaluation, and time management. For complete details, contact HRSP Inc., 3051 Adeline St., Berkeley, CA 94703, (415) 548-1364.

May 20-23
The Thirteenth Mid-Year Meeting of the American Society for Information Science, Indiana University, Bloomington. The theme for this meeting is "The Micro Revolution: Implications for the Information Age." Joseph Weizenbaum, author of *Computer Power and Human Reason* and a professor of computer science at Massachusetts Institute of Technology, will speak. For more information, contact Stephen Harter, School of Library and Information Science, Indiana University, Bloomington, IN 47405, (812) 335-5113.

May 20-25
The Fourth Jerusalem Conference on Information Technology—JCIT, Jerusalem, Israel. Papers, panel discussions, workshops, and exhibits will emphasize software engineering and manufacturing related to the theme of this international event, the "Next Decade in Information Technology." Until April 30, the registration fee is $200. After that date, the fee is $225. Isratech '84, the national exhibition of high technology, runs concurrently with JCIT. For information on Isratech '84, contact the Government of Israel Trade Center, 350 Fifth Ave., New York, NY 10118, (212) 560-0660. For details on JCIT, contact the Fourth Jerusalem Conference on Information Technology, POB 29313, 61292 Tel Aviv, Israel; tel: (03) 258-535.

May 21-23
AAMSI Congress 1984—The Third Spring Joint National Congress, Hilton Hotel, San Francisco, CA. Invited and contributed papers, special sessions, tutorials, reviews, panel discussions, and demonstrations will focus on the applications of computers and information technology and systems to all fields of medicine. Program sponsors include a dozen professional organizations that have joined the American Association for Medical Systems and Informatics (AAMSI) in pro-

ducing this three-day program. For particulars, contact AAMSI, Suite 402, 4405 East-West Highway, Bethesda, MD 20814, (301) 657-4142.

May 22–25
COMDEX Spring, Georgia World Congress Center, Atlanta. For details, contact the Interface Group, 300 First Ave., Needham, MA 02194, (800) 325-3330; in Massachusetts, (617) 449-6600.

May 22–26
Micro Expo '84, Palais des Congrés, Paris, France. Manufacturers and vendors of hardware, software, peripherals, and accessories for the microcomputer market will attend this conference and exposition. For details, contact Sybex France, Centre Paris Daumesnil, 4 Place Felix Eboue, 75583 Paris Cedex 12, France. In the U.S., contact International Show Coordinator, Sybex Inc., 2344 Sixth St., Berkeley, CA 94710, (415) 848-8233.

May 22–26
Oficomp Korea 84—The International Korean Office and Information Management Exhibition and Conference, Korea Exhibition Center, Seoul, South Korea. Exhibits will include demonstrations of computers, communications equipment, and business machines. Contact Clapp & Poliak International, POB 70007, Washington, DC 20088, (301) 657-3090.

May 23–24
Automach-Australia '84, Royal Hall of Industries Showground, Sydney. This trade show serves to update Australian manufacturing industries on automated, integrated factory systems incorporating numerically controlled machinery, CAD/CAM, and robotics. For details, contact Mr. Greco, Howard Rotavator Pty., POB 82, Parramatta 2150, New South Wales, Australia; tel: 630-1231; Telex: AA21328. In the U.S., contact SME World Headquarters, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-1500.

May 23–24
The 1984 Trends and Applications Conference, National Bureau of Standards, Gaithersburg, MD. Presentations will address current systems and applications as well as research into advanced concepts relating to the theme, "Making Database Work." Information can be obtained from Trends and Applications 84, POB 639, Silver Spring, MD 20901, (301) 921-3491.

May 23–25
The Eighth Conference on Computer Applications in Radiology, Stouffer's Riverfront Towers, St. Louis, MO. Patient information systems, personal computers and computers for the private office, teleradiology, computer-assisted instruction, and artificial intelligence are a few of the topics to be covered. Exhibits are included. The fee is $350. For details, contact American College of Radiology, 20 North Wacker Dr., Chicago, IL 60606, (800) 227-5463; in Illinois, (312) 236-4963.

May 23–25
The Third Annual European Semiconductor Industry Conference, Hotel Kempinski, Berlin, West Germany. International industry leaders will discuss issues facing the semiconductor industry. Contact Barbara Chupp, Dataquest Inc., 1290 Ridder Park Dr., San Jose, CA 95131, (408) 971-9000.

May 26–27
The Third Annual Toronto PET User's Group (TPUG) Conference, Constellation Hotel, Toronto, Ontario, Canada. This program con-

sists of formal speeches, product exhibits, and a trader's corner for used computer equipment. For information, contact Chris Bennett, TPUG Business Office, 1912A Avenue Rd., Toronto, Ontario M5M 4A1, Canada, (416) 782-9252.

May 29-31
Gulf Coast Computer and Office Show, New Orleans, LA. Speakers, technical sessions, and product displays will highlight this exhibition. For full details, contact Gulf Coast Computer and Office Show, 119 Avant Garde Circle, Kenner, LA 70062, (504) 467-9949.

June 1984

June 4-5
Electronic Motion Control Association Seminar, Chicago, IL. This educational program combines tutorial sessions with technical paper presentations. Devices and systems will be displayed. For details, contact the Electronic Motion Control Association, Suite 1200, 230 North Michigan Ave., Chicago, IL 60601, (312) 372-9800.

June 4-7
Electronics in Oil and Gas/U.S., Convention Center, Dallas, TX. This exhibition will focus on electronics technology as it applies to processing, production, supervision, data control, communications, testing, instrumentation, exploration, and safety associated with the petroleum and gas industry. The conference program, held concurrently with the World Oil and Gas Show and Conference, will cover telemetry, sensing, computers, simulation, and automation. Complete particulars are available from Martin C. Dwyer International, 1350 East Touhy Ave., Des Plaines, IL 60018, (312) 299-9311.

June 6-9
The 1984 Rochester FORTH Applications Conference, University of Rochester, NY. An international conference now in its fourth year, this convocation is appropriate for both experienced users and newcomers to the FORTH language. Invited speakers will discuss real-time systems and FORTH applications and techniques. Contact Diane Ranocchia, Institute for Applied FORTH Research Inc., 70 Elmwood Ave., Rochester, NY 14611, (716) 235-0168.

June 6-8
ACM SIGCOMM '84 Symposium on Communications Architectures and Protocols, Montreal, Quebec, Canada. Address inquiries to Rebecca Hutchings, Honeywell/FSD, 7900 Westpark Dr., McLean, VA 22102, (703) 827-3982.

June 11-15
Managing the Audit Computer-based Bank Systems, Chicago, IL. A course providing a comprehensive audit approach for evaluating and testing controls in computer-based bank systems. Information is available from Darlene Floading, Bank Administration Institute, 60 Gould Center, Rolling Meadows, IL 60008, (312) 228-6200.

June 12-14
Info/Software, McCormick Place, Chicago, IL. An exposition and conference devoted exclusively to demonstrations of applications and systems software. Mainframe, minicomputer, and microcomputer software will

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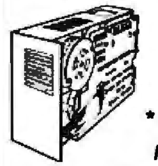

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be featured. Further information is available from Clapp & Poliak, 708 Third Ave., New York, NY 10017, (212) 661-8410.

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

June 13–15
The Sixth Annual National Educational Computing Conference—NECC '84, University of Dayton, OH. Papers, workshops, and exhibits are designed to promote a higher quality of classroom instruction in educational computing. Complete details on NECC '84 are available from Lawrence A. Jehn, Computer Science Department, University of Dayton, Dayton, OH 45469, (513) 229-3831.

June 13–15
PC-World Exposition, McCormick Place West, Chicago, IL. Further information can be obtained from Mitch Hall Associates, POB 860, Westwood, MA 02090, (617) 329-8090.

June 14–17
International Computer Show, Cologne, West Germany. Seminars, workshops, and hardware and software exhibits will highlight this international event focusing on informing users on buying-decision criteria, how to scrutinize software, and how to solve user's needs such as customer service, advice, and spare parts. Contact Messe- und Ausstellungs-Ges.m.b.H Köln, Messeplatz, Postfach 210760, D-5000 Cologne 21, West Germany; tel: (0221) 821-1; Telex: 8873 426 a mua d.

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

June 18–21
People, Computers, and FORTH Programming, Humboldt State University, Arcata, CA. This is a hands-on, introductory course for individuals wanting enough knowledge and experience with FORTH to write applications programs. In order to gain an understanding of some of FORTH's internal workings, experience using a computer language is advised. The fee is $125 or $175 with three quarter hours academic credit. Register with Claire Duffey, Office of Continuing Education, Humboldt State University, Arcata, CA 95521, or call (707) 826-3731.

June 18–22
Office Information System Software, Massachusetts Institute of Technology, Cambridge, MA. This course provides a systematic treatment of the concepts behind the design of multifunction office workstations, including technologies, human factors, software, and applications generators. Further information is available from the Director of the Summer Session, E19-356, MIT, Cambridge, MA 02139.

June 19–21
Computerized Office Equipment Expo, O'Hare Exposition Center, Rosemont, IL. For complete details, contact the show manager, Cahners Exposition Group, Cahners Plaza, 1350 East Touhy Ave., POB 5060, Des Plaines, IL 60018, (312) 299-9311.

June 20
How to Document a Computer System, Sheraton Commander Hotel, Cambridge, MA. For details, see April 27.

June 26–29
Using FORTH Effectively, Humboldt State University, Arcata, CA. This is a hands-on advanced course on the generation and internal operations of a FORTH system. A minimum of six months using FORTH and a knowledge of assembly language and operating-system principles are prerequisites. The fee is $150 or $200 with three quarter hours academic credit. Registration information is available from Claire Duffey, Office of Continuing Education, Humboldt State College, Arcata, CA 95521, (707) 826-3731. ■

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.

What's New?

REAL-WORLD INTERFACING

Interface Connects with RS-232C Ports

The Starbuck 8232 is a data-acquisition and control interface that connects with any computer through an RS-232C port. It comes with eight digital inputs, eight digital outputs, and eight 0- to 5-volt analog inputs with 8-bit accuracy. The 8232's built-in Motorola 6802 microprocessor provides 2K bytes of ROM and 2K bytes of RAM. Internal software permits buffered high-speed analog data acquisition at rates in excess of 7000 points per second and buffered data logging with storage for 2000 data points. Other programs may be downloaded to RAM.

All inputs are protected against overvoltage, and the outputs are optoisolated. Analog inputs are internally damped to reduce noise pickup. The 8232 can share an RS-232C line, and it lets you store analog data for later transmission. Communications are in ASCII. The 8232 can be battery-powered for remote-site applications.

The 8232 with operator manual costs $540. For complete specifications, contact Starbuck Data Co., POB 24, Newton Lower Falls, MA 02162, (617) 237-7695.

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Altertext Transfers Data Between Computers

Altertext Systems I and II transfer data between different makes of personal computers, word processors, and typesetting equipment. Stored data is said to be transferred in exactly the same format as the original. These stand-alone microcomputers can read and write both 5¼- and 8-inch floppy disks. The System I reads floppy disks and transfers files on line to a front-end system. It can retrieve information via telephone lines and write it to a disk. System II is suitable for those interested in disk-to-disk capabilities.

The standard Altertext System comes with 64K bytes of RAM, double-sided double-density 5¼- and 8-inch floppy-disk drives, keyboard, RS-232C serial port, printer port, video terminal, power supply, and communications cable. The detachable display monitor has an 80-character by 24-line format and a tilt-and-swivel base. Asynchronous communications protocols are standard. The data transfer rate ranges from 300 to 19,600 bps.

Bisynchronous communications, which emulate IBM 2770, 2780, 3780, and 3741 protocols, are offered as an option. A paper-tape interface and a printer equipped with both parallel and serial interface capabilities are also available. The System I comes with 5¼- and 8-inch floppy-disk drives. The System II has four drives, two of each format. Base prices are $12,000 and $20,000, respectively. For more information, contact Altertext Inc., 210 Lincoln St., Boston, MA 02111, (617) 426-0009.

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Home Control System Doesn't Tie Up Computer

Cyberlynx's Smarthome I is a hardware and software combination that allows an Apple or an IBM Personal Computer to monitor a security system and control electrical appliances without tying up the computer. Smarthome I is made up of a controller unit, wireless security sensors, a hand-held remote controller, power-line appliance controllers, and software. Electrical appliances can be programmed to respond to emergency situations, and Smarthome can be set to alert you to equipment malfunctions. Programming is done by using a joystick or mouse to move objects or icons around the video screen. A draw program lets you customize this system to your house. The controller unit features multitasking firmware that leaves your computer free to run other programs.

Smarthome I is offered in a start-up kit, which provides the necessary equipment to set up and operate a basic home-security system. Prices begin at less than $600. For full particulars, contact Cyberlynx, 4828 Sterling Dr., Boulder, CO 80301, (303) 444-7733.

Circle 608 on inquiry card.

Chromatography Automation System for Apples

The Adalab Chromatography Automation package for Apple II/IIe computers features menu-driven software, a data-acquisition/control card, and a chromatography interface module. The Chromatochart software supports up to four channels of simultaneous data acquisition and control for GCs (gas chromatographs), HPLCs (high-performance liquid chromatographs), and similar systems. It uses proprietary data-compression algorithms, which are said to permit more raw data storage than other systems. Chromatochart lets you calculate, review, edit, and store baseline information. Other attributes of the software include integration routines that determine retention time, height, width at half height, and symmetry. Data is stored in memory or on disk.

The Chromadapt Chromatography Interface Module amplifies detector signals and provides binary gradient control of HPLC pumps using Chromatograph software. Chromadapt is equipped with eight digital inputs and eight digital outputs that can sense switch conditions, control values, and so forth. In addition, its variable-scale D/A output permits playback of GC or HPLC data from computer memory to any analog strip-chart recorder or integrator.

A complete Adalab Chromatography Automation System can be obtained for $4280. Existing Apple IIs can be retrofitted for gradient HPLC or GC data acquisition. Retrofit prices begin at $1295. For further information, contact Interactive Microware Inc., POB 771, State College, PA 16801-0771, (814) 238-8294.

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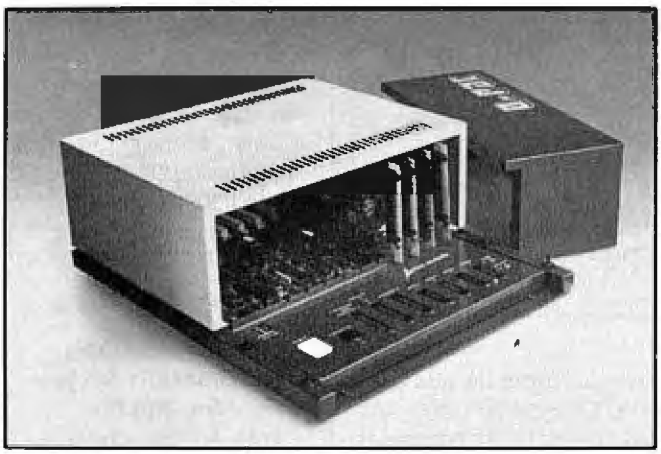


Industrial Micro Has Built-In A/D Interface

Action Instruments' A-Pac BC3 computer is designed for industrial data acquisition and control. It combines a built-in analog and digital I/O interface with a personal computer and a programmable logic controller. Salient features include 10 plug-in expansion slots, EPROM memory, battery-backed RAM, and clock/calendar.

A key element of the BC3 is a proprietary industrial software package known as ABLE (Action BASIC Language Enhancement). ABLE offers a wide set of control-oriented instructions. It lets one application program access another and allows parameters to interact between programs. Data logging, alarm and control annunciators, multiloop PID control, batch control, and distributed-processing applications programs are available. All the programs are said to minimize user programming.

Optional plug-in modules provide up to 256 inputs, including director sensors, thermocouples, strain-gauge and pressure transducers, analog voltages, and currents and digital logic levels. Outputs will control motors, industrial robots, solenoids, physical actuators, and solid-state relays. Action Instruments asserts that the BC3's on-board nonvolatile memory eliminates the need for peripheral memory devices.

An A-Pac BC3 start-up kit for basic applications costs $5999 and includes a CRT, keyboard, I/O interface, and cables. Quantity and OEM discounts are available. The single-unit price for the BC3 is $3500. For more information, contact Action Instruments, Industrial Computer Division, 8601 Aero Dr., San Diego, CA 92123, (619) 279-5726.

Circle 606 on inquiry card.

Control System for OEM or Product Development

The R8E Microcontroller, a stand-alone computer control system, is suitable for use as an OEM dedicated controller or as an industrial product-development system. It can be used as a security-system monitor, EPROM programmer, remote data logger, or print spooler. Configured as a programmable controller, data logger, or interface device, the R8E's transducers and AC devices can be directly connected. Eight channels of high- and low-level A/D inputs are standard, as are three parallel ports (two of which are Centronics-compatible), one RS-232C serial port with switch-selectable data rates, and solid-state power relays. The R8E uses the Zilog Z8671 chip, which is designed for control applications with both 8- and 16-bit capabilities.

The R8E can hold up to 16K bytes of user memory, expandable to 78K bytes. Memory can be RAM, ROM, or EPROM; 2K bytes of battery-backed RAM are supported. Programming is done through a resident BASIC interpreter.

An EPROM programmer system, a rough-service two-axis interface board, an 80-column by 25-line terminal, and a cassette recorder are optional. The R8E can be ordered in starter kit or full-development system packages. The starter system includes the controller, 2K-byte BASIC interpreter, AC power supply, interface cable, 4K-byte CMOS RAM, and machine manual. It lists for$449. The development system is made up of a 2K-byte battery-backed RAM, 12K-byte Q-static RAM, batteries, speaker, zero-insertion force socket for slot 0, 2-amp AC power supply, interface cable, and manual. It costs $569. Options begin at $7.95. Contact H. H. S. Microcontrollers, 5876 Old State Rd., Edinboro, PA 16412, (814) 734-4338.

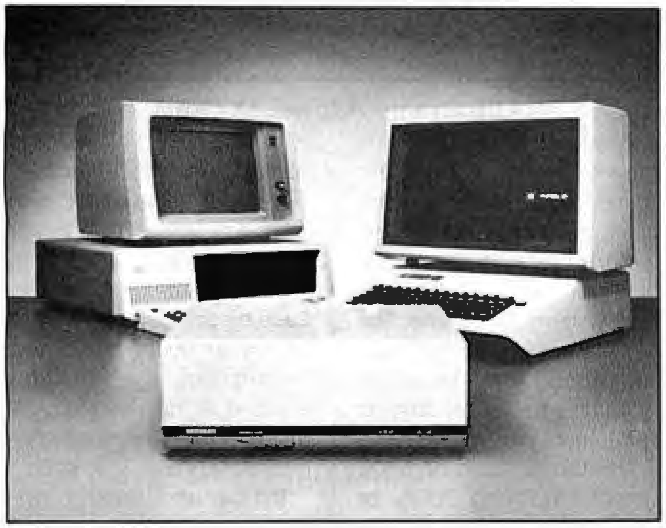
Circle 605 on inquiry card.

Data Acquisition and Control

The Analog Connection II from Strawberry Tree Computers is designed for laboratory and industrial applications including data logging, process monitoring, and process control. It will measure temperature, pressure, flow, and other analog inputs from voltage or current sources. Designed for use with Apple computers, the Analog Connection can switch heaters, fans, and pumps on and off at preset levels or from digital inputs. You can log data or display maximum, minimum, average, or difference of inputs. Alarm limits can be set for any input device, and input ranges and engineering units can be specified through menus. A menu that offers 10 different thermocouple types provides flexibility when measuring temperature. Linearization and cold-junction compensation are accounted for automatically.

Overall system accuracy is 0.04 percent. High noise rejection is 110 decibels, common mode, and 72 decibels, normal mode. Ten input ranges, which span from 25 millivolts to 10 volts and 2.5 to 50 milliamperes full scale, accept data from most sensors. The basic configuration of the Analog Connection consists of a single plug-in card with eight analog inputs and eight digital I/O lines. Data-acquisition software is provided. The Analog Connection can support as many as 48 analog inputs and 48 digital I/O lines.

Options include a battery-backed clock and a terminal box with cold-junction compensation for thermocouples. Prices start at $490. Contact Strawberry Tree Computers, 949 Cascade Dr., Sunnyvale, CA 94087, (408) 736-3083.
Circle 601 on inquiry card.



Workstations Provide Data Acquisition and Control

Keithley DAS Series 500 workstation measurement and control systems are compatible with Apple and IBM computers. The Series 500 can accept up to 10 expansion modules for analog, digital, and control functions. Its total capacity is 272 analog inputs, 50 analog outputs, 160 digital inputs or outputs, or 160 channels of AC or DC power control. The system is supplied with Soft500, an extension of BASIC for measurement and control applications. A real-time clock/calendar and three precision interval timers are standard.

Three preconfigured systems are available: the 510, 520, and 530. Designed for basic analog input and high-speed digitization, the Series 510 comes with a 12-bit A/D converter and provides 16 channels of single-ended input or 8 channels of differential, user-selectable by means of on-board DIP switches. Global signal conditioning for all analog channels and a 25-microsecond A/D conversion time are featured.

The Series 520, an extension of the 510, has 5 independent high-speed 12-bit D/A converters and 16 channels of optoisolated TTL-compatible digital I/O. Its power-control module allows direct switching of four AC power channels. The 530 provides 14-bit A/D conversion, two channels of 16-bit analog output, a 35-microsecond conversion time, and two channels of independent transient-free 16-bit A/D conversion.

Series 500 prices range from $2100 to $5500. Expansion modules begin at $250. For details on options and technical or ordering information, contact Keithley DAS, 349 Congress St., Boston, MA 02210, (617) 423-7780.
Circle 602 on inquiry card.

Card/Software Turn IBM Into Logic Analyzer

Total Logic Corporation's LA-200 provides the necessary hardware and software for transforming an IBM PC or PC XT into a logic analyzer. System hardware is made up of a plug-in card, test cables, and a color-coded probe pod. The data path is 32 bits wide, and the memory depth is 1024 data words. When used with the IBM's clock, the LA-200 operates synchronously or asynchronously at rates up to 15 MHz. Six hardware clock qualifiers allow flexibility in selecting data points of interest in complex mutliplexing applications. A sequential trigger mechanism lets you choose a variety of options, including one to eight sequential triggers for starting or ending a data trace. Multiple start/stop conditions can be created by using triggers. Captured data can be displayed in a variety of formats, including timing diagrams and binary, hexadecimal, octal, and ASCII codes.

LA-200 software gives you a menu from which to choose analyzer functions. Functions include setup, data collection, data display, data printing, data comparisons, and a data and setup parameter storage function. Full-screen editing and setup defaults are standard.

The LA-200 requires a 64K-byte IBM PC or PC XT with a single disk drive. It costs $1950 and is available from Total Logic Corp., Suite 110, 343 West Drake, Fort Collins, CO 80526, (303) 226-5980.
Circle 603 on inquiry card.

SYSTEMS

Vector 4-S Reads IBM Soft-Sectored Disks

The Vector 4-S microcomputer is an 8/16-bit machine capable of reading IBM Personal Computer, PC XT, and other soft-sectored floppy disks. Its floppy-disk drive is said to automatically detect the nature of the disk being used and whether the disk was created under MS-DOS or CP/M-86. Single- or double-density 8- and 9-sectored 48- or 96-tpi disks can be read.

The 4-S comes with CP/M-86, 128K bytes of RAM, GSX-86 Graphics, an 8-bit Microsoft BASIC interpreter, and an 8-bit CP/M simulator. A detached keyboard, a green-phosphor display, two modified S-100 expansion slots, a tone generator, an RS-232C communications port, and one serial and two parallel ports complete the 4-S unit. Options include MS-DOS, an external color monitor, up to 256K bytes of RAM, and a communications board and software providing IBM 2770, 2780, 3741, 3780, and 3270 protocol emulation and access to remote mainframes.

The single-user 4-S is available with one or two floppy-disk drives or one floppy drive and a 5-, 10-, or 36-megabyte hard-disk drive. Prices range from $3295 to $9995. For further details, contact Vector Graphic Inc., 500 North Ventu Park Rd., Thousand Oaks, CA 91320, (805) 499-5831.
Circle 610 on inquiry card.

Single-Board Computer Runs Multiuser DOSes

Heurikon Corporation's MLZ-92A, a Multibus-based single-board computer, can run multiuser operating systems without the need for additional expansion cards. Targeted at systems integrators, the MLZ-92A has an 8-MHz Z80A microprocessor; VLSI technology provides up to 128K bytes of parity-protected DRAM capable of accommodating two or three users. This board can access up to 1 megabyte through its 20-bit memory-mapped Multibus interface. Off-card I/O can be accessed through its I/O map. The MLZ-92A communicates with the Multibus as the master, as a slave, or in a multimaster mode.

Four RS-232C serial ports, two of which are configurable for RS-422 operation, an on-board disk interface, and a streaming-tape interface are standard. All drive ports are set up for an on-board DMA to allow rapid data transfers.

A floppy-disk controller for either 5¼- or 8-inch drives is optionally available. Four counter/timers, user-definable DIP switches and LEDs, dual ROM sockets, 9511/9512 mathematics chip, and CP/M can be obtained. The base price for the MLZ-92A is $1695. For complete specifications and ordering details, contact Heurikon Corp., 3001 Latham Dr., Madison, WI 53713, (800) 356-9602; (608) 271-8700.

Circle 614 on inquiry card.

Ultraframe Allows 32 Users

A modular design permitting expansion from a single-user 10-megabyte business computer to a multiuser system with 110 megabytes of storage highlights Independent Business Systems' Ultraframe. The manufacturer asserts that additional users can be connected to Ultraframe for as little as $598 each, plus terminal.

The Ultraframe is an S-100 system employing Z80A- or 80186-based single-board computers for multiple operators. When fully loaded, it provides more than 2 megabytes of RAM to as many as 32 users. A master Z80A handles disk and printer access, while each user works with a dedicated processor and RAM. Its operating systems are TurboDOS and IBS p-Net, which is compatible with UCSD Pascal.

Versions are available with 5-, 8-, or 14-inch Winchester hard disks offering from 10 to 145 megabytes of storage. Each model carries either 5¼- or 8-inch floppy-disk drives. Backup storage includes floppy-disk drives, 3M cartridge, or the IBS Backstop system, which uses videotape.

Independent Business Systems markets its products through systems integrators and OEM outlets. Full specifications and details on Ultraframe configurations can be obtained from Independent Business Systems Inc., 5915 Graham Court, Livermore, CA 94550, (415) 443-3131.

Circle 609 on inquiry card.

MC68000 Trainer Is for School and Industry

The Micro 68000ECB Microcomputer Trainer, a self-contained 16-bit MC68000 computer from Computer System Associates, is intended for training and educational use, including college-level courses and industrial in-plant training. This single-board computer comes with a 4-MHz MC68000ECB processor, a 6-amp switching power supply, a base plate, a Centronics-compatible parallel printer port, a cassette-tape serial I/O port, and a back plate that allows easy access to a pair of serial RS-232C ports. It contains 32K bytes of dynamic RAM, a 24-bit programmable timer, and a wire-wrap area for custom circuitry. A resident firmware package gives you a programming and operating environment and monitor, debugger, and disassembly/assembly functions.

The Micro 68000ECB comes in a hardwood and dark plastic see-through case. A briefcase to transport it is optional. The price is $985. A similar version with a hexadecimal keyboard and display lists for $1495. Contact Computer System Associates Inc., 7562 Trade St., San Diego, CA 92121, (619) 566-3911.

Circle 612 on inquiry card.

Multiuser Micro for Business Environment

Digitex has introduced the Quadradisk 6000, a series of multidisk, multiuser microcomputers designed for business and professional environments. Quadradisk has an S-100 bus, a 6-MHz Z80B processor, floppy-disk controller, 128K bytes of RAM, two serial ports, and a Centronics parallel port. Expansion to 4, 8, or 12 users is available with up to 896K bytes of memory. A cache-like virtual disk improves performance and can be expanded from 128K by employing unused user memory. A removable 5¼-inch 5-megabyte cartridge is offered in combination with a 1-megabyte floppy disk and 5-, 15-, 25-, or 40-megabyte Winchester drives. Up to four drives can fit into this desktop unit, and five slots provide space for other boards. Full-function displays and a complement of printers are offered.

System software includes Dataplus, a compiler and interpreter that allows operation of programs originally written for Datapoint computers. Quadradisk will operate under Oasis, CP/M, or TurboDOS. It can communicate with other microcomputers, Datapoint systems with bisync or async file send and receive, and IBM mainframes with IBM 2780/3780 bisync protocols. Vertical market application packages tailor the Quadradisk to office needs.

Retail prices start at $6160 for a 16-megabyte multiuser system with 128K bytes of RAM and one parallel and two serial ports. For further information, contact Digitex, 2044 Armacost Ave., Los Angeles, CA 90025, (800) 345-4839; in California, (213) 826-4500.

Circle 616 on inquiry card.

256K for Printer Spooling or RAM Disk

Companion Computers' CP/M 2.2 Companion adds the CP/M operating system and 256K bytes of storage, printer spooling, or port expansion capabilities to your portable computer or terminal. Typical applications for this 8-pound unit, which can serve as a stand-alone system, include expansion of single- and multiuser systems, bulletin-board host, and process control. Its Z80A processor partitions the 256K-byte RAM into 192K bytes of disk emulation and 64K bytes of user memory. CP/M 2.2 and utilities are supplied on a 5¼-inch floppy disk. The Companion is able to read and write IBM, Kaypro, Morrow, and Osborne double-density disks.

Two disk drives can be added to the Companion. Its four I/O ports are composed of two RS-232C serial ports with automatic data-rate selection ranging from 110 to 19,200 bps, a parallel port that defaults to Centronics compatibility, and a bus port for external drives and additional RAM and ROM. Any computer with RS-232C facilities can employ the Companion for disk-file access and RAM disk emulation.

The CP/M 2.2 Companion costs $1095. For full details, contact Companion Computers, PO Drawer CC, Apex, NC 27502, (919) 362-6655.

Circle 613 on inquiry card.

Bundled Software Complements Sinclair QL

The Sinclair QL comes with word-processing, spreadsheet, database-management, and graphics software that taps the capabilities of its 128K-byte RAM, dual 100K-byte Microdrives, and high-resolution color graphics. Motorola's 68008 microprocessor, a 32-bit processor with an 8-bit data path and 1 megabyte of nonsegmented address space, is at the heart of the QL. A second chip, the Intel 8049, tends to the QL's 65-key keyboard, sound, RS-232C receive, and real-time clock functions.

Character displays of 85 by 25 (normal), with a choice of character sets, and 40 by 60 (television) can be achieved, depending on the software. With a color or monochrome monitor, the high-resolution 512- by 256-pixel graphics give you eight colors and two operating modes. Nine rear-panel ports are provided: networking, serial communications, two joysticks, and ROM-cartridge and internal expansion. RGB monitor, power sockets, and a television port are standard. Up to 64 QLs or ZX Spectrums can be linked. Six Microdrives can be stacked externally for a total of 800K bytes of storage. RAM is expandable to 640K bytes.

System software is based on a 32K-byte ROM chip containing SuperBASIC and the QDOS operating system. QDOS, developed by Sinclair, features single-user multitasking, a time-sliced priority job scheduler, display handling for multiple screen windows, and device-independent I/O. Pascal and 68000 compilers will be announced. Hardware options include a modem and A/D, Winchester hard-disk, and IEEE-488 and parallel printer interfaces.

In the United Kingdom, the list price is £399, including VAT (value-added tax). In the U.S., it's $499 (third quarter availability). For information, contact Sinclair Research Ltd. USA, 50 Staniford St., Boston, MA 02114, (617) 742-4826.

Circle 615 on inquiry card.

Peripherals

High-Performance Color Graphics Card for IBM

IDE Associates' Ideagraph is a high-performance color graphics card for the IBM PC and PC XT. Based on the NEC 7220 color chip, Ideagraph comes in 28- or 40-MHz versions and with 128K or 256K bytes of memory. Both versions have the ability to generate four color planes (16 colors) at 640 by 200 pixels and hardware-driven functions that operate at 80 nanoseconds per pixel. Standard graphics features include automatic line, circle, vector, and space filling. A hardware-controlled zoom factor of 1 to 16 can be used to highlight specific areas, and display blinking is achieved on a pixel-by-pixel basis under software control.

Its optional color outputs are RGB intensity, TTL with color mapping, RGB analog, and NTSC composite video. An IBM-compatible BIOS, IDE-extended BIOS, and a virtual device interface designed to link with Digital Research's GSX are supplied. With 256K bytes of memory, Ideagraph can be programmed for eight color planes with 256 colors selectable from a palette of 4096.

Retail prices range from $895 to $1895, depending on configurations. For full particulars, contact IDE Associates Inc., 7 Oak Park Dr., Bedford, MA 01730, (617) 275-4430.

Circle 618 on inquiry card.

Six-Voice Synthesizer

The SCI Six-Voice Board is a single-board polyphonic synthesizer from Sequential Circuits. This serial-interfaced Z80A-driven synthesizer allows you to program each voice with a different timbre. It has computer-corrected analog electronics and provides you with independent control over tone, loudness, and the character of the sound. By mixing inputs you can create sounds resembling such instruments as trombones, organs, or banjos. It measures 9 by 6.2 inches and weighs 9 ounces.

In OEM quantities, the SC Six-Voice Board is under $200. For more information, contact Sequential Circuits Inc., 3051 North First St., San Jose, CA 95134, (408) 946-5240.

Circle 617 on inquiry card.

HX-20 Parallel Port Marketed

Computer Resources markets a parallel-port interface for the Epson HX-20 notebook computer. This board provides 24 parallel bits of fully buffered input, output, or bidirectional data (user-configurable in 8-bit segments). Up to 16 parallel-port boards can be daisy-chained off the HX-20's expansion connector. The list price is $250.

Additional boards to run off the parallel port include a connector/LED, a high-speed serial interface, an EPROM programmer, and D/A and A/D boards. Direct inquiries about prices and availability to Computer Resources Corp., POB 388, Provo, UT 84601, (801) 377-4446.

Circle 622 on inquiry card.

Stereophonic Sound Effects for Arcade Games

Stereophonic arcade sound effects can be created with the Soundmaster II from Kearsarge Industries. Soundmaster can be programmed through BASIC or assembly-language programs to produce such sounds as lasers, explosions, and race cars. Once addressed, it latches the data and frees the computer for other activities. Refresh is not required.

The Soundmaster card is outfitted with two sound-generating circuits with six tone generators, two noise generators, six mixers, amplitude controls, two envelope generators, and six D/A converters. A pair of audio amplifiers that drive dual 8-ohm speakers are on board. RCA plugs permit direct connection to stereo systems for further amplification.

Soundmaster works with Apple II, II Plus, and IIe computers. It comes with a manual and demonstration disk. It costs $119.95, plus $3.50 for shipping and handling. Order from Kearsarge Industries Inc., 12310 Pinecrest Rd., Reston, VA 22091, (703) 620-5760.

Circle 619 on inquiry card.

Video Digitizer Uses Standard RS-170 Camera

PCVision Frame Grabber, model DFB-512, from Imaging Technology, is a single-board video digitizer and frame buffer capable of digitizing the images from a standard RS-170 video camera and simultaneously displaying the image. Resolution is 512 by 480 pixels. The input video is digitized by a 6-bit A/D flash converter at a rate of 10 MHz. Digitized data is stored in a frame buffer and sent to the output section by means of a set of four 256 by 8 lookup tables. The output section uses an 8-bit D/A converter to change the data back to RS-170 format. The resulting image can be displayed on a television monitor.

PCVision lets you access and manipulate individual pixels. Accesses to the frame buffer are interleaved to prevent streaking. Each pixel is represented by 1 byte. A maximum of 512 by 512 by 4 pixels can be stored in the frame buffer. Other system features include a phase-locked loop circuit, a write-protect mechanism, a vertical blank interrupt, and a system clock configurable via software.

The PCVision Frame Grabber costs $2900 fully loaded. For details on options and purchasing procedures, contact Imaging Technology Inc., Suite 4350, 400 West Cummings Park, Woburn, MA 01801, (617) 938-8444.

Circle 620 on inquiry card.

PC Window Interface Supports Mouse

Visuall, a window interface for the IBM PC, PCjr, and PC XT, is manufactured by Trillian Computer Corporation of Los Gatos, California. Visuall creates a visual environment in which most actions and tasks can be selected from windows using a mouse or two keys. This arrangement eliminates complicated commands and speeds the training of novices. Visuall supports PC-DOS application programs without modifications.

When used in conjunction with application-specific shells, Visuall lets you customize up to 48 windows for a particular application. Windows can include Help screens explaining topics in paragraph form. Visuall lets you create shells for any program that runs on PC-DOS 1.1 or 2.0.

Visuall works with most available mouse hardware. It requires 64K bytes of memory and a single floppy-disk drive. With full documentation and a PC-DOS shell, Visuall costs $99.95. Application-specific shells for such programs as Lotus 1-2-3, Wordstar, Supercalc, Multiplan, and IBM Personal Editor are available for $49.95. A French DOS shell is offered. For complete details, contact Trillian Computer Corp., 129 Central Ave., POB 481, Los Gatos, CA 95031, (408) 374-5001.

Circle 627 on inquiry card.

What's New?

A Better BASIC Announced

Summit Software Technology has announced BetterBASIC for IBM Personal Computers. BetterBASIC is marketed in Starter Pack and Programmer versions, both of which are said to be totally interactive compilers. Major features of BetterBASIC include a modular architecture, structured design, and record-variable data types. It provides a group of text- and string-handling features, such as insert/delete and case conversions, and mathematic processing in binary-coded decimal form. It supports procedures, functions, and a range of block-structured commands and record-variable data types, including pointer variables, strings, and arrays of any type. The IBM PC's 640K-byte memory address space is supported.

BetterBASIC's modularity allows all new programming enhancements to be written into modules and added to the core language. The modules are self-contained, separately compiled software packages written in BetterBASIC and augmented by assembly language. They can be written, edited, renumbered, and listed just like standard BASIC programs. Modules include the main module, which supports the base language and contains fundamental MS-DOS key/screen I/O; the MS-DOS module, which adds statements for sequential and random access to MS-DOS files and devices; and an extension module with embedded BetterBASIC statements. Currently, modules for graphics and windows are offered. Future releases will support database management and virtual memory.

The BetterBASIC Starter Pack is $189, and the Programmer is $489. June shipments are planned. For more information, contact Summit Software Technology, 40 Grove St., Wellesley, MA 02181, (617) 235-0729.

Circle 626 on inquiry card.

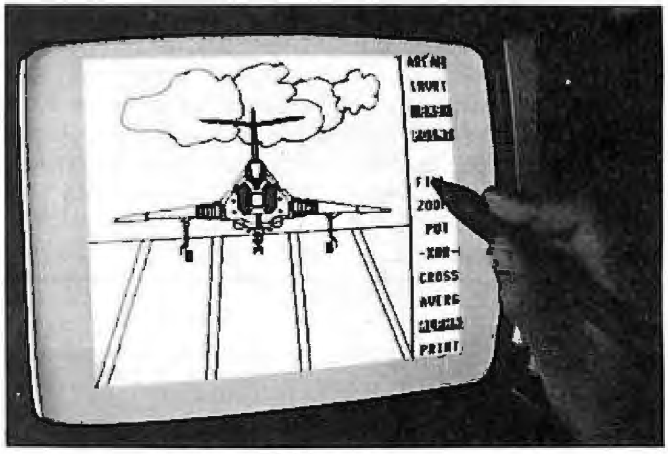
MS-DOS Formats Read by TRS-80s

Transfer from Michtron allows Radio Shack TRS-80 Models I, III, and 4 computers to read from and write to disks formatted by an MS-DOS-based machine, such as the Tandy 2000, Compaq, and Sanyo 550. Transfer offers five commands in its main menu: Read MS-DOS directory, Copy MS-DOS file to TRSDOS, Copy TRSDOS to MS-DOS, Sort MS-DOS directory, and Format an MS-DOS disk. You can use Transfer's Format function to format 40-track disks that your TRS-80 can read, and then let your Tandy 2000 convert these disks to an 80-track format. Transfer will copy any file from one disk format to another if the files are saved in ASCII. Also supplied is a utility, CONV, which adds spaces around keywords in BASIC programs written on the TRS-80 so that they will run on Microsoft BASIC.

Transfer requires two disk drives. On the Model I, a doubler and a 40-track drive are required. For the Model III, transfer will operate under TRSDOS, NewDOS, DOSPlus, or LDOS. Available for $59.95 from Michtron, 1691 Eason, Pontiac, MI 48054, (313) 673-1205.

Circle 638 on inquiry card.

Light Pen and Software Create Graphics on 64



Inkwell Systems' Flexidraw for the Commodore 64 is a graphics program coupled with a light pen. It provides the means for producing simple freehand sketches or complex CAD drawings using pencil-and-paper routines and all the speed and graphics capabilities of the 64. The program features a dynamic menu for operator convenience and a variety of automatic graphic selections. A few of the graphics abilities are point-to-point lines; box, circle, and fill choices; zoom; two separate work areas; and Put/Get commands for manipulating images on screen or transferring images between the two work areas. Graphics can be stored on disk or output to a printer.

The light pen will work on standard televisions and black-and-white, color, and most green-screen monitors. Response time is purported to be 175 nanoseconds with a two-line capability.

Flexidraw is $149.95 and includes the light pen, software, keyboard overlay, and manual. Further information can be obtained from Inkwell Systems, 7760 Vickers St., POB 85152 MB 290, San Diego, CA 92138, (619) 268-8792.

Circle 630 on inquiry card.

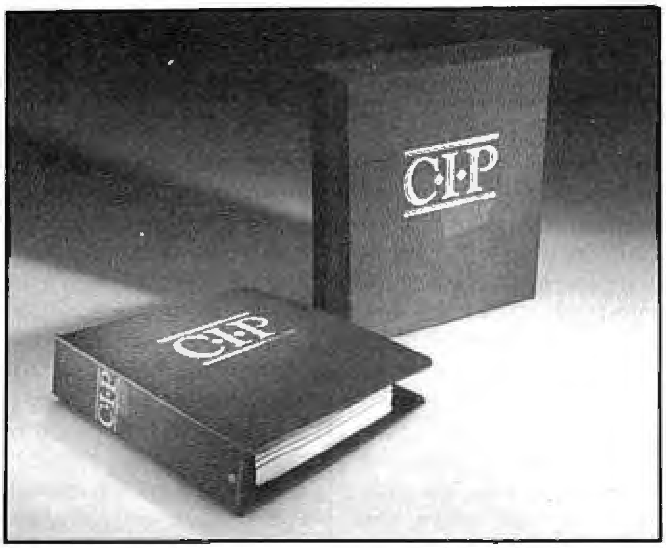
Natural-Language Interpreter at Heart of DBM

Salvo is an information manager from Software Automation. At the heart of Salvo is a relational database-management system and a natural-language interpreter that translates syntax-free user requests into commands. It has a knowledge-based algorithm that permits automatic navigation through the database without user direction. An Expert Command Assistant feature helps you formulate commands in a nontechnical manner. A command set capable of complete application generation independent of external host languages is standard. Salvo's Virtual Join capability dynamically creates views of joined relations without physically creating result tables.

Salvo is designed to operate in both stand-alone and distributed data-processing modes. When operating in an executive workstation, it is capable of accepting data from a host processor. You can then develop custom application programs without programming by using Salvo as a common front-end language. It automatically generates detailed how-to instructions, which allow you to communicate in a natural language the results you wish to obtain. In addition, you can use graphics to help formulate information requests.

Compatible with such DOSes as MS-DOS 1.1 and 2.0, CP/M, and CP/M-86, Salvo requires a minimum of 64K bytes of memory and dual 256K-byte floppy-disk drives. It costs $495, complete with manual, system disk, data disk, sample applications programs, and tutorials. Full details are available from Software Automation Inc., 14333 Proton Rd., Dallas, TX 75234, (800) 527-4070; in Texas, (214) 392-2802.

Circle 629 on inquiry card.



Database/Information Manager Handles Report Writing

A database/information management and report-writing program for the IBM Personal Computer is marketed by Concentric Data Systems. With the Concentric Information Processor (CIP), what you see on screen is what you get on hard copy. CIP offers a horizontal scrolling capability so that 132-column documents can be visually defined using an 80-column display. Titles and footnotes can be created on screen and formatted in conjunction with the report. Information definition, collection, and reporting are done through the visual interface.

CIP does not require a command language, and complicated key combinations, parameters, switches, and user-defined screen positions have been eliminated. All options are presented on screen, and the use of command keys and pointing techniques are consistent. A calculation facility that includes date arithmetic is provided. Standard features include context-sensitive instructions, key graphics, flexible file reorganization, and Help screens.

CIP will work with such products as Visicalc, Mailmerge, and Lotus 1-2-3. It can read files from PFS: or dBASE II. The suggested retail price is $395. Further information is available from Concentric Data Systems Inc., 18 Lyman St., Westboro, MA 01581, (617) 366-1122.

Circle 628 on inquiry card.

Business Software Line for HP 150

The Accounts Journal (TAJ) business-software line from Production Data Systems is available for the Hewlett-Packard HP 150. The product line for the HP 150 includes Accounting Pac, TAJ Job Costing Pac, TAJ Financial Graphics Pac, and TAJ Forms Pac. The Accounting Pac is an integrated single-disk package containing general ledger, accounts receivable/payable, and payroll functions. TAJ Job Costing Pac, which is capable of operating as a stand-alone program, tracks all labor time, costs, and revenues per job. Pie, line, and bar charts of financial data contained in the Accounting Pac can be generated with the Financial Graphics Pac. Forms Pac produces billing statements, payroll checks, accounts payable checks, and W-2 forms.

The Accounting Pac is $850. Job Costing lists for $425. Financial Graphics Pac and Forms Pac are $250 each. All prices include documentation. For more information, contact Production Data Systems, Suite 210, 2386 Fair Oaks Blvd., Sacramento, CA 95825, (916) 484-0155.

Circle 636 on inquiry card.

Preview-Paks Demo Software on Reusable Disks

Preview Publishing has announced Preview-Pak, a 10-pack of reusable floppy disks containing full demonstrations of IBM PC programs. Each disk represents one of ten categories, which range from word processing and database management to graphics, operating systems, and small business accounting. When you are through with a disk, you can reformat it for personal use.

Preview-Paks are supplied with tutorial booklets and discount coupons. The manufacturer intends to feature different demonstration software on a monthly basis. A 10-pack costs approximately $40. For details, contact Preview Publishing, 534 Third Ave., San Francisco, CA 94118, (415) 752-3336.

Circle 633 on inquiry card.

Microsoft Releases Programs for Macintosh

Microsoft has announced a line of software for the Apple Macintosh. Available products include Multiplan, Word, Chart, File, and Microsoft BASIC. Each Microsoft program works with the Macintosh's graphics environment by providing you with a set of icons from which to choose desired functions. Microsoft's programs support cutting and pasting of information in Macintosh windows and among each other.

Multiplan for the Macintosh has been enhanced with an Undo command for reversing the last change to the spreadsheet. Word uses the Macintosh's graphics capabilities for full visual representations of text and graphics on screen, including proportional spacing and support for all Macintosh fonts. Chart, a business graphics program that lets you enter, edit, and format graphics data directly on screen, accepts data from Multiplan, File, or other Macintosh programs. File offers forms-based data entry and retrieval. Microsoft BASIC uses the Macintosh's 68000 processor to provide you with a decimal mathematics pack with 14-digit precision, string variables, string expressions as large as 32,767 characters each, and three window areas.

Microsoft intends to announce more programs for the Macintosh. Microsoft Multiplan, Word, and File cost $195

each. Chart is $125, and Microsoft BASIC lists for $150. Contact Microsoft Corp., 10700 Northup Way, Bellevue, WA 98004, (206) 828-8080.
Circle 637 on inquiry card.

Apples Draw with Flying Colors

A low-cost color graphics package for Apple computers, Flying Colors is marketed by the Computer Colorworks division of Jandel Inc. Flying Colors has a windowed screen menu that contains all the options you require to create drawings on your Apple II Plus or IIe. Choices include thick and thin lines, automatic circles and boxes of any size, erasures, and enclosed-area fill. A "micro" mode lets you focus on detailed work or paint with a selection of colors, patterns, and brush sizes. Text can be intermingled with graphics on screen. A projection program is provided for generating slide shows or presentations. Flying Colors lets you store drawings on disk as standard binary files that can be used in or combined with other programs.

Flying Colors is designed for use with a joystick. Versions of the program are available for Atari and Commodore computers. The price for the Apple program is $39.95. Contact the Computer Colorworks, Suite 201, 3030 Bridge Way, Sausalito, CA 94965, (800) 874-1888; in California, (415) 331-3022.
Circle 632 on inquiry card.

Integrated Utilities

Filedriver, an integrated collection of utilities for use in CP/M, MP/M, and TurboDOS systems, furnishes you with tools for generating application-specific, customized utilities. Its custom feature lets you create your own COM files with all the utility functions desired, specified options selected, and an entire command line consisting of one or more file IDs. Directions to read file IDs from a text file previously created are included. This arrangement lets you invoke complex utilities with a minimum number of keystrokes.

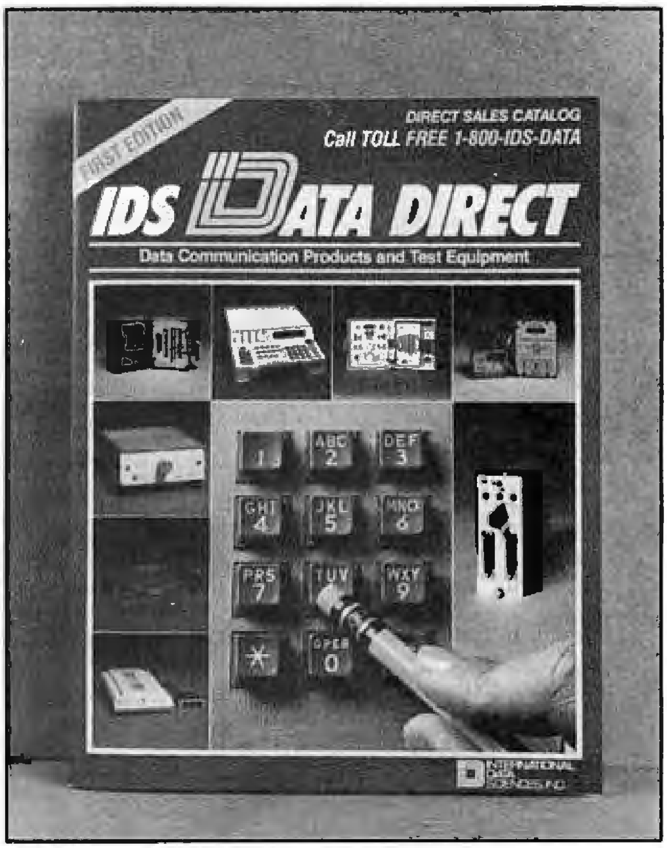
You can access Filedriver utilities from individual COM files, all-in-one COM files, or a menu interface. Among the basic utility functions constituting Filedriver are Archive, CSUB, Copy, Erase, Rename, Print, and Verify. Each function has built-in features that expand upon the utilities supplied with the DOSes. These features include multiple wild cards on a command line, wild-card user-areas and disk drives, as well as the ability to exclude lists of files from wild-card designations, write to and read from text files, and copy/archive to sequential floppy drives.

Filedriver does not modify existing operating systems; rather it runs in consort with other utilities and menu interfaces. With a user manual, the 8-inch version of Filedriver is $85. Most 5¼-inch floppy-disk formats are $90. In-depth documentation containing application notes, summary charts, and appendixes is supplied. Descriptive literature can be obtained from Dunbar-Ridge Corp., 102 Sterling Court, Syosset, NY 11791, (516) 496-4431.
Circle 634 on inquiry card.

PUBLICATIONS

Catalog Outlines Data-Communications Products

International Data Sciences' IDS Data Direct catalog describes more than 60 data-communications products.



This 36-page catalog and buyer's guide profiles such equipment as an RS-232C hand-held test set and breakout box, data switches, modems, and cables. Product descriptions include illustrations, schematic diagrams, specifications, and pricing information. Many of the items are available in both stand-alone and rack-mounted configurations. Articles offering guidelines for testing data-communications networks and practical applications for the use of switching, patching, and monitoring modules are interspersed throughout.

IDS Data Direct is free of charge. For your copy, contact International Data Sciences Inc., 7 Wellington Rd., Lincoln, RI 02865, (800) 437-3282; in Rhode Island, (401) 333-6200.
Circle 650 on inquiry card.

Where Do New Products Items Come From?
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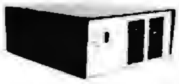

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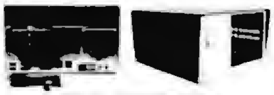

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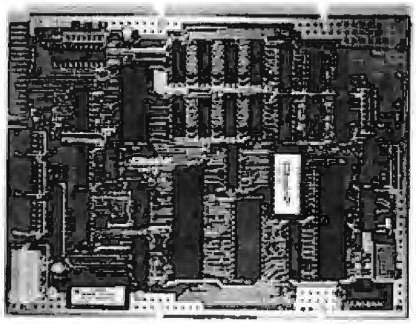

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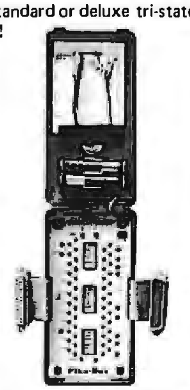

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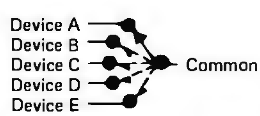

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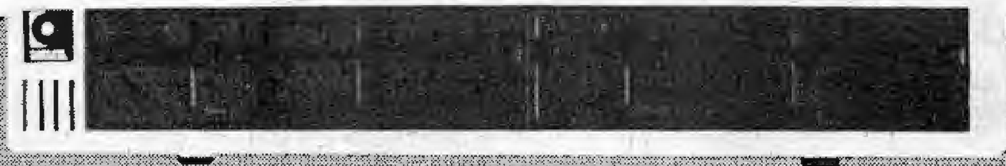

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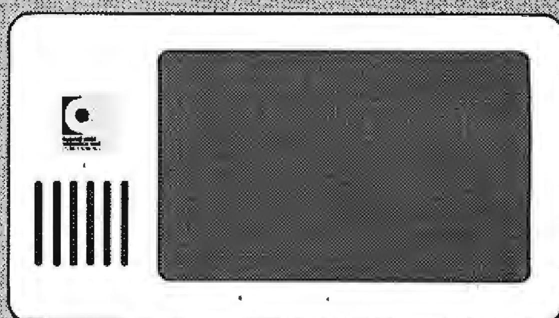

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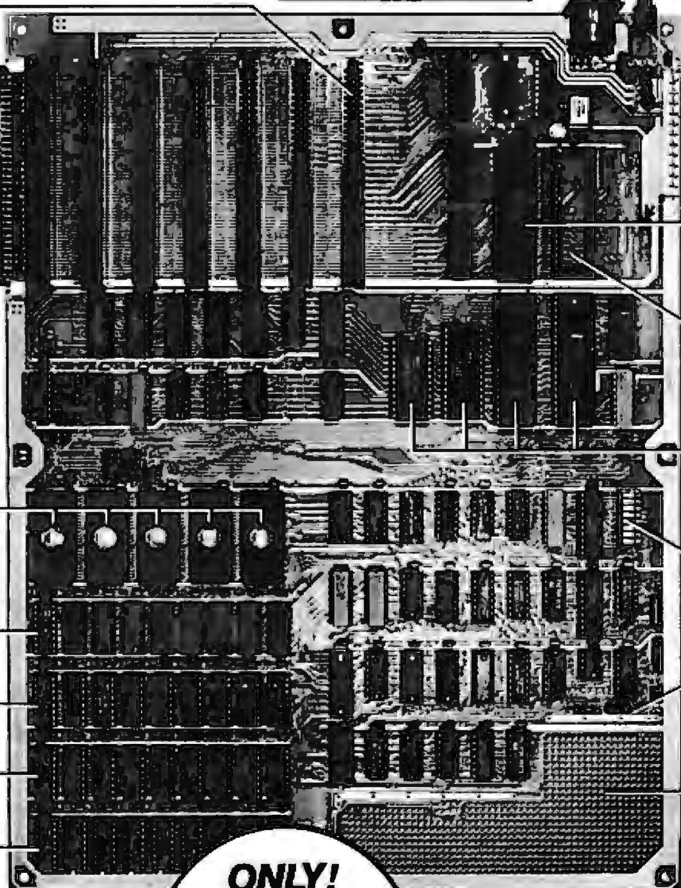

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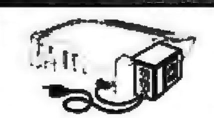

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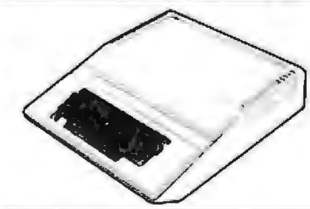

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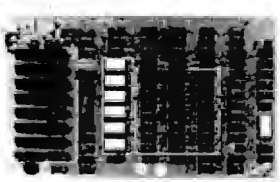

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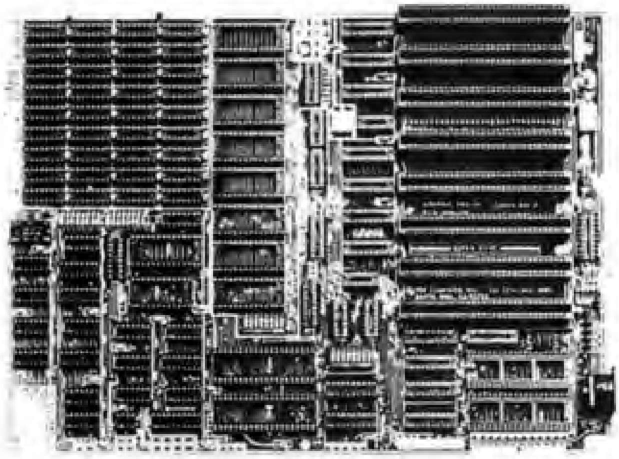

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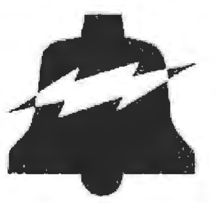

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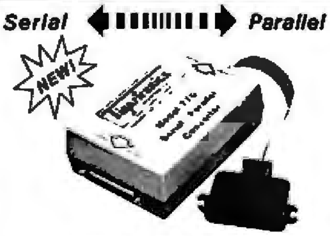

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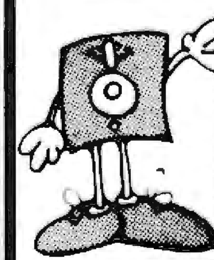

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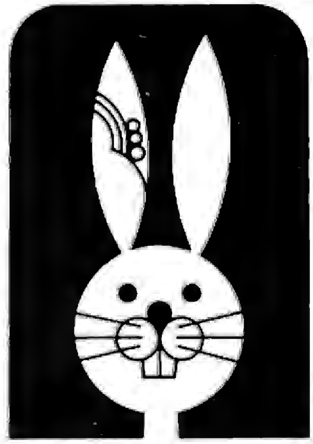

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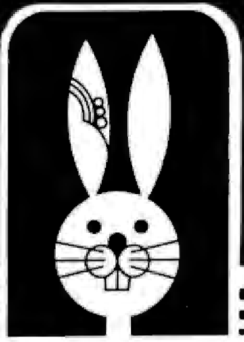

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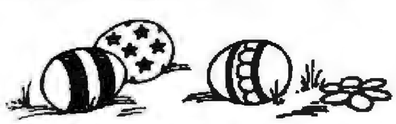

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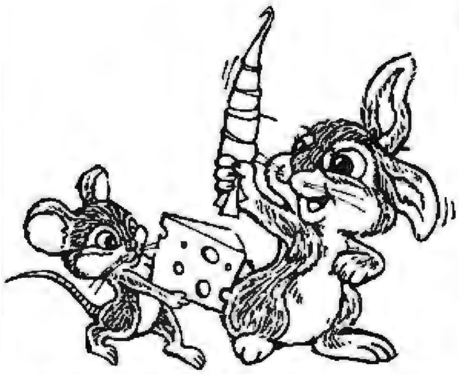

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VERBATIM	VRB-550/01 / VRB-550/10 / VRB-550/16	39.95	37.95	32.75
	MRX-3491 / MRX-3493 / MRX-3495	35.00	31.25	26.25
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		27.75	26.60	22.25
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EIGHT INCH SINGLE SIDED DOUBLE DENSITY

	MMM-741/0	37.75	35.15	29.15
		35.50	33.50	27.15
VERBATIM	VRB-34/8000	35.25	33.25	28.75
DYSAN	DYS-3740/1D	40.75	38.75	32.25
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California Digital has just purchased a new distribution center six times the size of our existing facility. The new warehouse and retail store is in the city of Carson at 17700 Figueroa Street. We are located just off the San Diego Freeway near the Goodyear Blimp. Please stop by and visit our retail store when in the Los Angeles area. Store hours are 10 AM to 5 PM Monday through Saturday.

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4164 150ns. 64K 128 refresh	ICM-4164150	5.95	5.85	5.55
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2716TMS 450ns. Tri-voltage	ICE-2716TMS	7.95	7.65	7.25
2732 450ns. 4K x 8	ICE-2732	4.50	3.75	3.55
2732 350ns. 4K x 8	ICE-2732350	8.50	8.00	7.60
2532 450ns. 4K x 8	ICE-2532	10.50	9.90	9.50
2764 350ns. 8K x 8	ICE-2764	6.95	6.95	6.95
27128 350ns. 16K x 8	ICE-27128	18.95		

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21L02 450ns. 1K static	ICM-21L02450	1.29	1.15	.99
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2114 300ns. 1K x 4	ICM-2114300	1.95	1.85	1.75
4044TMS 450ns. 4K x 1	ICM-4044450	3.49	3.25	2.99
5257 300ns. 4K x 1	ICM-5257300	2.50	2.25	1.99
6116 P4 200ns. 2K x 8	ICM-6116200	4.85	4.65	4.50
6116 P3 150ns. 2K x 8	ICM-6116150	5.25	4.05	4.85
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DB25S female	3 25	3 10	290
57-30360 male	1 60	1 35	1 30
57-30360 female	1.95	1 75	1 35
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26pin edge	420	3 95	365
26pin socket	5 95	5 75	5 50
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California Digital has just purchased a large quantity of Remex RFD-4000 Eight inch double sided disk drives. Remex is the only double sided disk drive that has an double gimbal mounted head assembly that guaranties lower head tracking. This drive is mechanically solid. Remex has always been known for producing premiere products for the floppy disk market. The Remex company is a subsidiary of the Ex-cell-o Corporation, a Fortune 500 Company.

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Eight Inch Double Sided Drives

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QUME 842 "QUME TRACK 8"	459	459	449
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MITSUBISHI M2894-63	447	439	433
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SHUGART SA400L	235	229	225
SHUGART SA410 96TPI/80 Trk.	129	129	119
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Five Inch Double Sided Drives

TEAC FD55B half height	219	209	199
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REMEX RFD480 IBM/PC	199	189	175
SHUGART SA450	319	309	299
SHUGART SA455 Half Height	259	249	239
SHUGART SA465 Half Ht. 96TPI	289	279	269
TANDON TM50-2 Half Height	215	209	199
TANDON TM55-4 half Ht. 96TPI	329	319	309
TANDON 100-2	279	269	259
TANDON 101-4 96TPI 80 Track	369	355	350
MITSUBISHI 4851 Half Height	259	249	245
MITSUBISHI 4853 ½ Ht. 96TPI	339	329	319
MITSUBISHI 4854 ½ Ht., 8" elec.	465	449	439
QUME 142 Half Height	239	229	219

Three Inch Disk Drives

SHUGART SA300 with diskette	229	219	209

Five Inch Winchester Hard Disk Drives

SHUGART 612	13 M/Bytes	895	865	825
SHUGART 706	6 M/Byte, Half Ht	795	775	755
SHUGART 712	13 M/Byte, ½ Ht.	895	865	825
TANDON 503	19 M/Byte	895	875	855

Upon request, all drives are supplied with power connectors and manual

ENCLOSURES

California Digital manufactures an asortment of stock and custom disk drive enclosures. If the volume is justified we will custom design an enclosure for your application. The following stock disk drive enclosures are available. All include power supplies the 8" enclosures are supplied with exhaust fans.

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DRAGON $139

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This is the ideal low cost computer to be used with any dial up information system such as the Source, Western Union's EasyLink or any other time share service.

California Digital has agreed to act as exclusive agent for North America in an effort to assist The Tano Corporation in reducing their overstock. For a limited time California Digital can offer the Dragon computer for only $139.

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$289 Star Gemini

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Star Gemini Delta 10 160 Char/sec	STR-D10	495 00
Star Coex 80FT friction & tractor	VST-C80FT	22900
Toshiba P1350 192 char/sec letter quality	TOS-1350	149500
Okidata 82A serial & parallel 9½ paper	OKI-82A	37900
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Okidata 83A & parallel 15 paper	OKI-83A	619 00
Okidata 84A & parallel 15 paper	OKI-84A	101900
Okidata 2350 [illegible] 350 char sec	OKI-2350	199500
Epson FX80 10 160 char sec with graphics	EPS-FX80	529 00
Epson MX100 with graphics 15 paper	EPS-MX100	58900
NEC8023A parallel 9½ paper graphics	NEC-8023A	38900
Anadex 9501A high speed with graphics	ADX-9501A	109900
Anadex 9620A 200 char/sec par & serial	ADX-9620A	119900
Quantex 7030 correspondence quality 180 char/sec	QTX-7030	1595 00
Gorilla low cost dot matrix printer	PRO-7500	18900
Prowriter 8510 parallel 9½ paper	PRO-8510P	35900
Prowriter II, parallel 15 paper, graphics	PRO-2P	68900
Dataproducts B-600 3, band printer 600 LPM	DPS-B600	698500
Printronix P300 high speed printer 300 lines per minute	PTX-P300	425000
Printronix P600 ultra high speed 600 lines per minute	PTX-P600	579500
Transtar 130P par I, IBM/PC compatible	TNS-130P	62900

WORD PROCESSING PRINTERS

NEC7710 55 char/second serial interface	NEC-7710	197900
NEC7730 55 char/sec par I interface	NEC-7730	197900
NEC3550 popular printer designed for the IBM PC	NEC-3550	179900
NEC2050 designed for IBM PC 20 char sec par I	NEC-2050	99500
Silver Reed EXP500 14 char sec par I interface	SRD-EXP500	459 00
Silver Reed EXP550 17 Char sec par I interface	SRD-EXP550	659 00
Diablo 630 40 char/sec serial	DBL-630	176500
Diablo 620 proportional spacing horz & vert tab 20cps	DBL-620	87900
Juki 6100 18 char/sec graphic mode	JUK-6100	53900
Brother HR1A daisy wheel, parallel interface	BTH-HR1P	69500
Brother HR1A serial interface	BTH-HR1S	77900
Starwriter F10 serial 40 char/sec	PRO-F10S	112500
Starwriter F10 parallel 40 char/sec	PRO-F10P	112500
Comrex CR1 word processing printer serial intr	CRX-CR1S	72900
Comrex CR2 5k buffer, proportional spacing par I	CRX-CR2P	49500

MONITORS

BMC 12A green phosphor 15 MHz compositvideo	BMC-12A	79 00
[illegible]	BMC-12EN	134 00
Zenith ZVM121 Amber Phosphor 12 40/80columnswitch	ZTH-122	119 00
Zenith ZVM123 green phosphor 12 40/80columnswitch	ZTH-Z123	10500
[illegible]	NEC-JB1201	169 00
[illegible]	NEC-JB1260	129 00
[illegible]	USI-12A	169 00
[illegible]	MOT-BW23	15900
[illegible]	MOT-BW12	6900
[illegible]	CON-BW9	5900
COLOR		
[illegible]	BMC-9191	249 00
[illegible]	BMC-9191M	499 00
[illegible]	NEC-1203	699 00
[illegible]	NEC-JC1201	339 00
[illegible]	ZTH-Z134	37900
[illegible]	COM-6500	32900
[illegible]	AMK-100	32900

MODEMS

DIRECT CONNECT $75

[illegible]	HYS-212AD	499 00
[illegible]	HYS-1200B	449 00
[illegible] Auto Dial	HYS-103AD	229 00
[illegible]	HYS-MM2	279.00
[illegible]	HYS-100	319 00
[illegible]	HYS-CHR232	199 00
[illegible]	USR-212A	439 00
[illegible]	USR-PW212	389 00
[illegible]	PEN-12AD	695 00
[illegible]	UDS-103LP	169 00
[illegible]	UDS-103LPJ	219 00
[illegible]	UDS-202LP	219 00
[illegible]	UDS-212LP	359 00
[illegible]	NOV-JCAT	115 00
[illegible]	NOV-CAT	159 00
[illegible]	NOV-SC103	219 00
[illegible]	NOV-SC212	529 00
[illegible]	SGL-MK1	75 00

TERMINALS

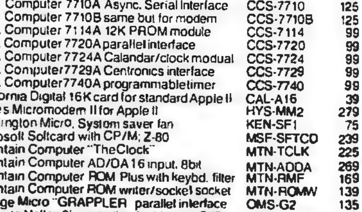
Perkin Elmer 550S

California Digital has recently purchased an OEM liquidation, of new Perkin-Elmer Bantam 550S terminals. These units feature direct cursor addressing, numeric cluster, conversational or block mode transmission and RS-232 printer port. Self diagnostics and function keys make this terminal an excellent value at only $339.00. PRK-550S

$339

Perkin-Elmer Model 550S Bantam Terminal	PRK 550S	339 00
Freedom 100 split screen detachable keyboard	LIB F100	495 00
Qume 102 green phosphor terminal	QUM 102	539 00
Visual 50 Green screen	VSL-50G	650 00
Ampex Dialogue 125 green screen	APX-0125G	675 00
Ampex Dialogue 175 amber screen two page func keys	APX-0175A	719 00
Wyse 50 14 green phosphor	WYS 50	595 00
Wyse 100 horz & vert split screen [illegible]	WYS-100	795 00
Wyse 300 Eight color display split screen	WYS 300	1159 00
Televideo 910 Plus block mode	TVI-910P	575 00
Televideo 925 detachable keyboard 22 function keys	TVI-925	750 00
Televideo 950 graphic char split screen 22 func	TVI-950	950 00
Televideo 970 14 green screen 132 column European	TVI 970	1095 00
Zenith 29 terminal VT52 compatible detachable keyboard	ZTH-Z29	765 00

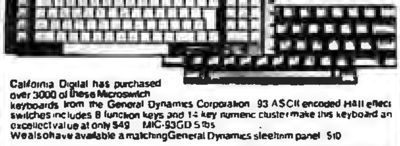
APPLE



$929

Apple II/e, 64K computer only	APL-2E	$989
Apple II/e starter kit, monitor, disk, 80 col. card.	APL-2ESK	1365
Advanced Busness Tech. 13 Key Pad	ABT-13B	109
Calif. Computer 7710A Async. Serial Interface	CCS-7710	125
Calif. Computer 7710B same but for modem	CCS-7710B	125
Calif. Computer 7114A 12K PROM module	CCS-7114	99
Calif. Computer 7720A parallel interface	CCS-7720	99
Calif. Computer 7724A Calandar/clock modual	CCS-7724	99
Calif. Computer 7729A Centronics interface	CCS-7729	99
Calif. Computer 7740A programmable timer	CCS-7740	99
California Digital 16K card for standard Apple II	CAL-A16	39
Hayes Micromodem II for Apple II	HYS-MM2	279
Kensington Micro, System saver fan	KEN-SF1	75
Microsoft Softcard with CP/M; Z-80	MSF-SFTCD	239
Mountain Computer "TheClock"	MTN-TCLK	225
Mountain Computer AD/DA 16 input, 8bit	MTN-ADDA	269
Mountain Computer ROM Plus with keybd. filter	MTN-RMF	169
Mountain Computer ROM writer/socket socket	MTN-ROMW	139
Orange Micro "GRAPPLER" parallel interface	OMS-G2	135
Sorrento Valley 8" controller double side D/D.	SVA223	395
TEAC 5¼" disk drive for Apple II	TEA-A2	269
Vista Vision 80; 80 column card for std.Apple II	VSA-VIS80	289
Vista 8" disk controller double side D/D	VSA-A800	389

ASCII KEYBOARD $49



California Digital has purchased over 3000 of these Microswitch keyboards from the General Dynamics Corporation 93 ASCII encoded Hall effect switches includes 8 function keys and 14 key numeric cluster make this keyboard an excellect value at only $49 MIC-93GD 5 lbs

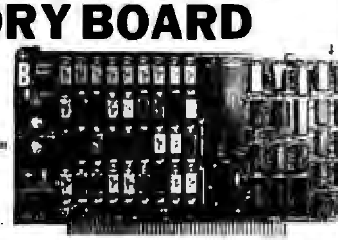
We also have available a matching General Dynamics steel form panel $10

Non-encoded Hytek 58 key metal contact keyboard HIK-58 $24.95 Matching 15 key numeric cluster $9.95 HIK-15 Both for only $29.95 HIK-5815

Not pictured 48 key eight bit encoded [illegible] Microswitch Hall effect keyboard REMOVED from punch card equipment $14.95 DIT KB48 ASCII encoder available

256 KILOBYTE MEMORY BOARD

$495



- 256 kilobytes of memory using 64k dynamic RAM
- Over one megabyte of memory using the new 256K dynamic RAM chips.
- Errordetection-trapcapability.
- Individual 16Kblock can be relocated to any boundry within a megabyte of RAM.
- 24 bit addressing and phantom mode capability.

The California Digital 256K RAM board represents an outstanding value in S 100 memory technology. Priced slightly above earlier generation 64K dynamic ram boards it gives you these additional features 256K of memory with parity. Parity error feature can be jumpered to any of the interrupt lines, a status port ERROR LED or IEEE-696 "ERROR signal" 24 or 16 bit addressing with memory management

Proper operation with front panel equipped systems DMA disk controllers and IEEE-696 Temporary Buss Masters assured with an on the board M1 generator for memory refresh timing. CAS and RAS timing is controlled with tapped digital delay lines for proper operation over the entire operating temperature range

The board is very recent in design using the National Semiconductor DP 8409 RAM Controller chip. Spot termination networks are used on all address lines, CAS line and RAS lines eliminating the last traces of ringing. The board uses two separate voltage regulators. One for the DRAMs and one for the interface logic increasing the noise immunity of the ram array. Typical power dissipation 15.8 watts

Documentation includes theory of operation, configuration guide, a schematic, and application notes on the use of the memory management options CAL-256K 2 Lbs

S-100 BOARDS

16 BIT MICROPROCESSORS

Octagon dual CPU 8088 Z80 & controller	OCT-88Z80	795 00
Godbout 8086/8087 microcomp 16bit	GBT 8687	49500
Godbout dual processor 8085-8088 8/16	GBT 8588	359 00

SINGLE BOARD COMPUTERS

Insight EO-4 128K 4serial notS-100	INS-EO4	595 00
Advanced Digital Floppy & 64K	AMD-Z80	750 00
Teletek Systemmaster 765 floppy 64K	TEL-SM1	895 00
Teletek FDC-1 single board no memory	TEL-FDC1	675 00

8 BIT MICROPROCESSORS

Godbout Z80 24 bit extended adr	GBT-Z80	250 00
California Computer Z80 microprocessor	CCS-2810	275 00
Tarbell Z80 with two RS232 ports	TAR-780	339 00

FLOPPY DISK CONTROLLERS

Godbout Disk 1, double density	GBT-DSK1	395 00
California Computer 2422A with CPM	CCS-2422	339-00
Morrow Disk Jockey II with CPM 2 2	MOS-DJ2	350 00
Morrow Disk Jockey I with CPM sgl Den	MOS-DJ1	225 00
Tarbell Electronics double density	TAR-DDC	419 00
Tarbell Electronics single density	TAR-SDC	279 00
Fulcrum DMA OmniDisk I/O to hard disk	FCM-OD1	389-00

CPM OPERATING SYSTEM

Digital Research CP/M 3 0 8 sgl den	DRC CpM30	249 00
Godbout CPM 2 2 for Disk 1	GBT-CpM22	159 00
Godbout CPM86 for 8088 and 8086	GBT-CpM86	265 00
Tarbell Electronics CPM 2 2	TAR-CpM22	159 00

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Octagon hard disk controller with ECC	OCT-HD1	475 00
Godbout Disk2 8 & 14 harddisk	GBT DSK2	56900
Godbout Disk3 for 5¼ Winchesters	GBT DSK3	
Morrow Designs controller for 5¼ Win	MOS W506	49500
Western Digital new WD-1001 (not S-100)	WDI-1001	49500

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Inner Access EPROM Bd programs 27128	IAC P400	465 00
Digital Research PROM board 32K	DGR-P32	179 00

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Godbout Ram 16 64K 16 bit data trans	GBT-R16	499 00
Godbout Ram 17 64K 8bit 24 bitaddress	GBT-R17	389 00
Godbout Ram 21 128K byte 8/16 transfer	GBT-R21	859 00
Fulcrum OmniRam 8/16 transfer bank	FCM-R816	395 00
California Computer 2116 Rom only	CCS-2116	249 00

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California Digital 256K expand to 1 Meg	CAL-D256	435 00
California Comp 2066 64K bank select	CCS-2066	295 00

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Godbout Interfacer I 2 serialports	GBT-133A	239 00
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Godbout Interfacer III with 5 serial ports	GBT 135A	499 00
Godbout Interfacer III with 8 serialports	GBT 136A	580 00
Godbout Interfacer IV 3 serial 2 parallel	GBT 187A	329 00
California Computer 2710 4 serialports	CCS-2710	279 00
California Computer 2719 2 serial 2 par I	CCS-2719	295 00
California Computer 2720 4 port par I	CCS-2720	219 00
California Computer 2830 6 port serial	CCS-2830	379 00
Morrow Designs Multiboard 3 S/2P	MOS-MTL1	319 00

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Artec Electronics wire wrap prototype	ART-WW100	25 00
Artec Electronics general purpose solder	ART-GP100	2500

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Godbout Enclosure2 20 slots	GBT-MF20	675 00
California Comp der 2200 12 slot	CCS-2200	479 00
California Digital 18 slot mother board	CAL MB18	35 00
Godbout 12 slot mother board assemb.	GBT MB1.	149 00

CP/M SOFTWARE

AdaSoft CP/M	ADA-445C	395 00
D-Base II	ASH-015C	429.00
Wordstar	MPR-187C	309.00
Mailmerge	MPR-392C	169.00
Spellstar	MPR-429C	169.00
Multiplan	MSF-483C	189.00
Macro 80	MSF-187C	139.00
Supersoft	MPR-309C	149.00
MAC	DGR-401C	85.00
CP/M 3.0	DGR-410C	249.00
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MP/M II	DGR-208C	379.00

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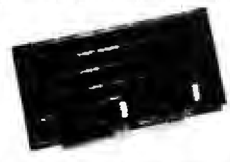

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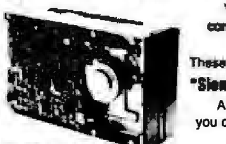

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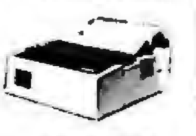

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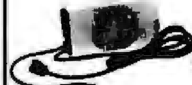

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420 RGB III Hi Res. (IBM Cabinet)	559.00
121 TTL Green 12" (IBM Cabinet)	179.00
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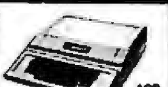

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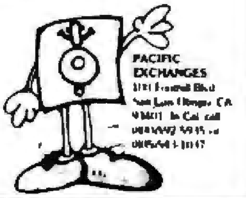

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Best buy in letter quality printers. NEW! from Comrex! full featured letter quality printer. FREE! 5K buffer, logic seeking bi-directional printing, boldface proportional spacing, double-strike, backspace, underline, true super-script and sub-script, drop-in daisy wheel cartridge

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Stand-alone Microbuffers

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TMM2016-100	2048 x 8 (100ns)	6.10
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HM6116-2	2048 x 8 (120ns) (cmos)	8.90
HM6116LP-4	2048 x 8 (200ns) (cmos)(LP)	5.90
HM6116LP-3	2048 x 8 (150ns) (cmos)(LP)	6.90
HM6116LP-2	2048 x 8 (120ns) (cmos)(LP)	9.95
Z-6132	4096 x 8 (300ns) (Qstat)	33.95

LP = Low Power   Qstat = Quasi-Static

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MK4108	8192 x 1 (200ns)	1.90
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4116-200	16384 x 1 (200ns)	.89
4116-150	16384 x 1 (150ns)	1.20
2118	16384 x 1 (150ns) (5v)	4.90
4164-250	65536 x 1 (250ns)	4.45
4164-200	65536 x 1 (200ns) (5v)	5.45
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2758	1024 x 8 (450ns) (5v)	5.90
2716	2048 x 8 (450ns) (5v)	2.95
2716-1	2048 x 8 (350ns) (5v)	5.90
TMS2516	2048 x 8 (450ns) (5v)	5.45
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TMS2532	4096 x 8 (450ns) (5v)	5.90
2732	4096 x 8 (450ns) (5v)	3.95
2732-250	4096 x 8 (250ns) (5v)	8.90
2732-200	4096 x 8 (200ns) (5V)	10.95
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2764-250	8192 x 8 (250ns) (5v)	13.95
2764-200	8192 x 1 (200ns) (5v)	23.95
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27128	16384 x 8 Call	19.95

5v = Single 5 Volt Supply

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74LS00	.23	74LS92	.54
74LS01	.24	74LS93	.54
74LS02	.24	74LS95	.74
74LS03	.24	74LS96	.88
74LS04	.23	74LS107	.38
74LS05	.24	74LS109	.38
74LS08	.27	74LS112	.38
74LS09	.28	74LS113	.38
74LS10	.24	74LS114	.38
74LS11	.34	74LS122	.44
74LS12	.34	74LS123	.78
74LS13	.44	74LS124	2.85
74LS14	.58	74LS125	.48
74LS15	.34	74LS126	.48
74LS20	.24	74LS132	.58
74LS21	.28	74LS133	.58
74LS22	.24	74LS136	.38
74LS26	.28	74LS137	.98
74LS27	.28	74LS138	.54
74LS28	.34	74LS139	.54
74LS30	.24	74LS145	1.15
74LS32	.28	74LS147	2.45
74LS33	.54	74LS148	1.30
74LS37	.34	74LS151	.54
74LS38	.34	74LS153	.54
74LS40	.24	74LS154	1.85
74LS42	.48	74LS155	.68
74LS47	.74	74LS156	.68
74LS48	.74	74LS157	.64
74LS49	.74	74LS158	.58
74LS51	.24	74LS160	.68
74LS54	.28	74LS161	.64
74LS55	.28	74LS162	.68
74LS63	1.20	74LS163	.64
74LS73	.38	74LS164	.68
74LS74	.34	74LS165	.94
74LS75	.38	74LS166	1.90
74LS76	.38	74LS168	1.70
74LS78	.48	74LS169	1.70
74LS83	.59	74LS170	1.45
74LS85	.68	74LS173	.68
74LS86	.38	74LS174	.54
74LS90	.54	74LS175	.54
74LS91	.88	74LS181	2.10

74LS189	8.90	74LS363	1.30
74LS190	.88	74LS364	1.90
74LS191	.88	74LS365	.48
74LS192	.78	74LS366	.48
74LS193	.78	74LS367	.44
74LS194	.68	74LS368	.44
74LS195	.68	74LS373	1.35
74LS196	.78	74LS374	1.35
74LS197	.78	74LS377	1.35
74LS221	.88	74LS378	1.13
74LS240	.94	74LS379	1.30
74LS241	.98	74LS385	1.85
74LS242	.98	74LS386	.44
74LS243	.98	74LS390	1.15
74LS244	1.25	74LS393	1.15
74LS245	1.45	74LS395	1.15
74LS247	.74	74LS399	1.45
74LS248	.98	74LS424	2.90
74LS249	.98	74LS447	.36
74LS251	.58	74LS490	1.90
74LS253	.58	74LS624	3.95
74LS257	.58	74LS640	2.15
74LS258	.58	74LS645	2.15
74LS259	2.70	74LS668	1.65
74LS260	.58	74LS669	1.85
74LS266	.54	74LS670	1.45
74LS273	1.45	74LS674	9.60
74LS275	3.30	74LS682	3.15
74LS279	.48	74LS683	3.15
74LS280	1.95	74LS684	3.15
74LS283	.68	74LS685	3.15
74LS290	.88	74LS688	2.35
74LS293	.88	74LS689	3.15
74LS295	.98	74LS783	23.95
74LS298	.88	81LS95	1.45
74LS299	1.70	81LS96	1.45
74LS323	3.45	81LS97	1.45
74LS324	1.70	81LS98	1.45
74LS352	1.25	25LS2521	2.75
74LS353	1.25	25LS2569	4.20

6500

1 MHZ

6502	4.90
6504	6.90
6505	8.90
6507	9.90
6520	4.30
6522	6.90
6532	9.90
6545	21.50
6551	10.85

2 MHZ

6502A	6.90
6522A	9.90
6532A	10.95
6545A	26.95
6551A	10.95

3 MHZ

6502B	9.90

6800

68000	58.95
6800	3.90
6802	7.90
6808	12.90
6809E	18.95
6809	10.95
6810	2.90
6820	4.30
6821	3.20
6828	13.95
6840	11.95
6843	33.95
6844	24.95
6845	13.95
6847	10.95
6850	3.20
6852	15.70
6860	9.90
6862	10.95
6875	6.90
6880	2.20
6883	21.95
68047	23.95
68488	18.95

6800 1MHZ

68B00	9.95
68B02	21.25
68B09E	28.95
68B09	28.95
68B10	6.90
68B21	6.90
68B45	18.95
68B50	5.90

8000

8035	5.90
8039	6.90
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INS-8073	49.95
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8085	5.90
8085A-2	10.95
8086	28.95
8087	CALL
8088	38.95
8089	88.95
8155	6.90
8155-2	7.90
8156	6.90
8185	28.95
8185-2	38.95
8741	38.95
8748	49.95
8755	23.95

Circle 131 on inquiry card.

8200

8202	23.95
8203	38.95
8205	3.45
8212	1.75
8214	3.80
8216	1.70
8224	2.20
8226	1.75
8228	3.45
8237	18.95
8237-5	20.95
8238	4.45
8243	10.95
8250	18.95
8251	4.45
8253	6.90
8255	14.95
8255-5	18.95
8257	7.90
8257-5	8.90
8259	6.85
8259-5	7.45
8271	38.95
8272	38.95
8275	28.95
8279	8.90
8279-5	9.00
8283	6.45
8284	14.95
8286	6.45
8287	6.45
8288	24.00
8289	48.95

Z-80

2.5 MHZ

Z80-CPU	3.90
Z80-CTC	3.95
Z80-DART	10.95
Z80-DMA	13.95
Z80-PIO	3.95
Z80-SIO/0	11.95
Z80-SIO/1	11.95
Z80-SIO/2	11.95
Z80-SIO/9	11.95

4.0 MHZ

Z80A-CPU	4.29
Z80A-CTC	4.90
Z80A-DART	9.95
Z80A-DMA	12.95
Z80A-PIO	4.29
Z80A-SIO/0	12.95
Z80A-SIO/1	12.95
Z80A-SIO/2	12.95
Z80A-SIO/9	12.95

6.0 MHZ

Z80B-CPU	9.95
Z80B-CTC	12.95
Z80B-PIO	12.95
Z80B-DART	12.95

ZILOG

Z6132	33.95
Z8671	38.95

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1791	23.95
1793	25.95
1795	48.95
1797	48.95
2791	53.95
2793	53.95
2795	58.95
2797	58.95
6843	33.95
8272	38.95
UPD765	38.95
MB8876	28.95
MB8877	33.95
1691	16.95
2143	17.95

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AY3-1014	6.90
AY5-1013	3.90
AY3-1015	6.90
PT-1472	9.90
TR1602	3.90
2350	9.90
2651	8.90
TMS6011	5.90
IM6402	7.90
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INTERFACE

8T26	1.54
8T28	1.84
8T95	.88
8T96	.88
8T97	.88
8T98	.88
DM8131	2.90
DP8304	2.24
DS8835	1.94
DS8836	.98

VOLTAGE REGULATORS

7805T	.74	7905T	.84
78MO5C	.34	7908T	.84
7808T	.74	7912T	.84
7812T	.74	7915T	.84
7815T	.74	7924T	.84
7824T	.74	7905K	1.44
7805K	1.34	7912K	1.44
7812K	1.34	7915K	1.44
7815K	1.34	7924K	1.44
7824K	1.34	79L05	.78
78L05	.68	79L12	.78
78L12	.68	79L15	.78
78L15	.68	LM323K	4.90
78H05K	9.90	UA78S40	1.90
78H12K	9.90		

C,T = TO-220 K = TO-3 L = TO-92

DIP SWITCHES

4 POSITION	.84
5 POSITION	.89
6 POSITION	.89
7 POSITION	.94
8 POSITION	.94

IC SOCKETS

	1-99	100
8 pin ST	.12	.10
14 pin ST	.14	.11
16 pin ST	.16	.12
18 pin ST	.19	.17
20 pin ST	.28	.26
22 pin ST	.29	.26
24 pin ST	.29	.26
28 pin ST	.39	.31
40 pin ST	.48	.38
64 pin ST	4.20	call

ST = SOLDERTAIL

8 pin WW	.58	.48
14 pin WW	.68	.51
16 pin WW	.68	.57
18 pin WW	.98	.89
20 pin WW	1.04	.97
22 pin WW	1.34	1.23
24 pin WW	1.44	1.30
28 pin WW	1.64	1.44
40 pin WW	1.94	1.75

WW = WIREWRAP

16 pin ZIF	5.90
24 pin ZIF	7.90
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ZIF = TEXTOOL (Zero Insertion Force)

CRYSTALS

32.768khz	1.69
1.0 mhz	3.89
1.8432	3.69
2.0	2.69
2.097152	2.69
2.4576	2.69
3.2768	2.69
3.579535	2.69
4.0	2.69
5.0	2.69
5.0688	2.69
5.185	2.69
5.7143	2.69
6.0	2.69
6.144	2.69
6.5536	2.69
8.0	2.69
10.0	2.69
10.738635	2.69
14.31818	2.69
15.0	2.69
16.0	2.89
17.430	2.69
16.0	2.69
18.432	2.69
20.0	2.69
22.1184	2.69
32.0	2.69

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1000 pcs	15.00

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SSDD	22.95
DSDD	27.95

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NO LABEL

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2716	16K EPROMS	2.95
2732	32K EPROMS	3.95
2764	64K EPROMS	5.95
27128	128K EPROMS	19.95
4164	64K DYNAMIC 250ns	4.45
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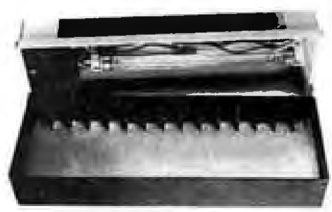
4164	64K DYNAMIC 150ns	6.45
2114	450ns	8/7.95

QUV-T8/1 EPROM Eraser



$57.95

QUV-T8/1 Economy Model: This is a low cost EPROM Eraser housed in a plastic enclosure. The UV element and components are installed in the top lid and you place the EPROMS in the bottom half. No timer or switch option is included.

- **Erases up to 8 EPROMS in 15 to 20 minutes.**
- **12,000 u Watts at 1" distance.**
- **90-Day Warranty**

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Santa Clara, CA 95050

Circle 131 on inquiry card.

Circle 132 on inquiry card.

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VIDEX	SALE PRICE
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VT-601 .... VIDEOTERM 60.Hz SOFTSWITCH	230.22
VT-602 .... VIDEOTERM 60.Hz SOFTSWITCH INVER	237.68
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ENH-FS-001 .... ENHANCER II, FUNCTION STRIP	133.37

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NEC JB1205 ...... MONITOR	177.50
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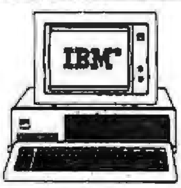

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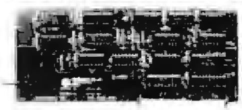

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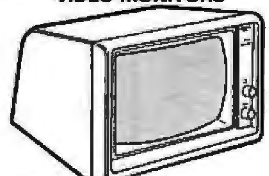

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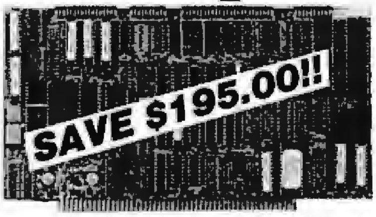

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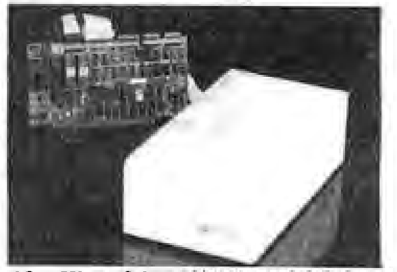
Octagon



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BAPD8171ACPM	DISK 1 (A&T) w/CP/M® 2.2	$670.00	$469.00
	When purchased with two 8" disk drives:		$450.00
BDBBT54016	DISK 1 Floppy controller (A&T)	$495.00	$425.00
BDGBT41000	CP/M® 2.2 for Z80/8085 w/manuals & BIOS, 8" S/D Disk		$146.95
BDBBT41050	CP/M-86® for CPU 8085/88 & CPU 8086/87 CPUs w/manuals, BIOS 8" S/D Disk		$249.00
BDGBT54025	DISK 2 8" hard disk controller w/CP/M® 2.2 (A&T)	$795.00	$725.00
BDBBT54030	DISK 3 ST-506 type 5¼" hard disk controller w/CP/M-80® & CP/M-86® (A&T)	$795.00	$725.00

I/O BOARDS

BDGBT58010	System Support 1 Multifunction I/O (A&T)	$450.00	$375.00
BDGBT58010/58531	SS1 w/8231 Math Chip A&T	$645.00	$570.00
BDBBT58010/58320	SS1 w/8232 Math Chip A&T	$645.00	$570.00
BDGBT53030	Interfacer 3 - 8 port serial (A&T)	$699.00	$599.00
BDGBT53040	Interfacer 4 - 3 Serial, 1 Centronics Parallel, 1 Parallel (A&T)	$450.00	$389.00

8/16 BIT MEMORY BOARDS

BDBBT52016	RAM 16 12MHz 32K Static A&T	$ 550.00	$ 495.00
BDGBT52021	RAM 21 12 MHz 128K Static A&T	$ 995.00	$ 895.00
BDGBT52022	RAM 22 12MHz 256K Static A&T	$1750.00	$1649.00
BDGBT52012	M-Drive/H 512K RAM Disk A&T	$1475.00	$1195.00

MAINFRAMES

BDGBT51200	20 Slot Desk Top (A&T) (55 lbs.)	$925.00	$795.00
BDGBT51250	20 Slot Rack Mount (A&T) (55 lbs.)	$975.00	$850.00

For more CompuPro Specifications see pages 2 - 33 of our New Catalog

Vector

Manufactured by Vector Electronic Co. under license from CompuPro

BDVCT8800GFB	Interfacer 1, 2-Serial (A&T)	$295.00	$219.00
BDVCT8800GF2B	Interfacer 2, 3-Par., 1-Ser. (A&T)	$325.00	$239.00
BDVCT8800GR17B	RAM 17 64K 10MHz Static RAM (A&T)	$450.00	$389.00

CompuPro is a registered trademark of CompuPro

SDSystems A SYNTECH COMPANY

		List Price	SALE Price
BDSDS36095	SBD-300 4MHz Z80A CPU A&T	$ 741.00	$ 619.00
BDSDS36092	SBD-300 6MHz Z80B CPU A&T	$ 825.00	$ 689.00
BDSDS36007	Z80 Starter System A&T	$ 450.00	$ 399.00
BDSDS36086	ExpandoRAM IV 256K A&T	$1145.00	$ 975.00
BDSDS36089	ExpandoRAM IV 256K w/EDC A&T	$1990.00	$1675.00
BDSDS36097	ExpandoRAM III/696 256K	$ 825.00	$ 749.00
BDSDS36076	PROM-100 w/software A&T	$ 285.00	$ 219.00
BDSDS36082	RAM Disk 256K A&T	$ 875.00	$ 775.00
BDSDS36081	ROM Disc 128K A&T	$ 350.00	$ 319.00
BDSDS36096	I/O-8 4-Port Async Ser. A&T	$ 600.00	$ 549.00
BDSDS36093	I/D-8 8-Port Async Ser. A&T	$ 695.00	$ 589.00
BDSDS36094	I/D-8 4 Sync, 4 Async, 8-Port Serial I/O A&T	$ 795.00	$ 699.00
BDSDS36099	Versafloppy III Floppy & ST-506 Hard Disk Controller	$ 895.00	$ 759.00
BDPDBVF339145*	w/5¼" unbanked CP/M® 3.0	$1083.00	$ 868.00
BDPDBVF339146*	w/8" unbanked CP/M® 3.0	$1083.00	$ 868.00
BDPDBVF339147*	w/5¼" banked CP/M® 3.0	$1083.00	$ 865.00
BDPDBVF339148*	w/8" banked CP/M® 3.0	$1083.00	$ 865.00
BDSDS36098	Versafloppy II/696 (A&T)	$ 400.00	$ 344.00
BDPDBVF239141*	w/5¼" unbanked CP/M® 3.0	$ 588.00	$ 424.00
BDPDBVF239142*	w/8" unbanked CP/M® 3.0	$ 588.00	$ 424.00
BDPDBVF239143*	w/5¼" banked CP/M® 3.0	$ 588.00	$ 424.00
BDPDBVF239144*	w/8" banked CP/M® 3.0	$ 588.00	$ 424.00

*CP/M-Plus™ (3.0) configured for the SBC-300

See Complete Specifications on Pages 12-25 Of Our '83/'84 Engineering Selection Guide

NEW! Octagon

BOARD LEVEL PRODUCT

BDOCT8087NOP	8087 for CPU 8/16		$ 300.00
BDOCTCPM86	CP/M-86®		$ 150.00
BDOCTCONCPM86	Concurrent CP/M-86®		$ 195.00
BDOCTMPM86	MP/M-86®		$ 495.00
BDOCTHDC	ST-506 Hard Disc Controller	$ 595.00	$ 525.00
BDOCTHDSUB19	19.2Mb Hard Disc Subsystem	$2295.00	$1895.00
BDOCTS256T00	256K Static RAM (A&T)	$1850.00	$1719.00
BDOCTD512K	512K Dynamic RAM (A&T)	$1450.00	$1345.00

See Specifications on Pages 12-27 Of Our '83/'84 Engineering Selection Guide

COMPLETE OCTAGON 8/16™ SYSTEMS

BDOCT816SMPM	w/256K Static RAM & MP/M-86™	$7350.00
BDOCT816SCCPM	w/256K Static RAM & Concurrent CP/M-86	$7350.00
BDOCT816DMPM	w/512K Dynamic RAM & MP/M-86	$7350.00
BDOCT816DCCPM	w/512K Dynamic RAM & Concurrent CP/M-86	$7350.00

See Complete Specifications on Page 5 Of Our New '83/'84 Engineering Selection Guide

Circle 301 on inquiry card.

ADVANCED DIGITAL CORPORATION

Z80 SINGLE BOARD COMPUTERS

Part Number	Description	List Price	SALE Price
BDADCSUP6128	Super Six 6MHz 128K Master w/1 ADC PS1 RS232 Serial Adapter	$995.00	$849.00
BDADCSPRSLV6128	Super Slave 6MHz 128K	$695.00	$595.00
BDADCSBC15	SuperQuad for 5¼" drives	$750.00	$695.00
BDADCSBC18	Super Quad for 8" drives	$750.00	$695.00

SOFTWARE & I/O PORT ADAPTERS

BDADCPS1	PS/Net1 RS232 Serial Adapter	$ 35.00
BDADCCPSP	Centronics Parallel Port Adapter	$ 35.00
BDADCCPM22*†	Advanced Digital CP/M® 2.2	$150.00
BDADCCPM30*†	Advanced Digital CP/M Plus™ (3.0)	$350.00
BDADCTDOS4U*†	TurboDos® 1, 2, or 4 Multi-user	$550.00

*Replace * with Q to specify Super Quad; S for Super Six

† Replace † with 8 for 8" IBM® 3740 format, 48 for 5¼" 48 TPI format or 96 for 5¼" 96 TPI format.

ST506/SA1000 HARD DISK CONTROLLER

BDADCHDC10015	ST506 5¼" Winchester Cont.	$500.00	$450.00
BDADCHDC10018	8" Winchester Cont.	$500.00	$450.00
BDADCHDCINSTL	Install program for use with non-ADC CPU board (Supplied on 8" CP/M® compatible disk)		$ 10.00

See Complete Specifications on Pages 14 - 27 of our '83/'84 Engineering Selection Guide

MACROTECH International Corp

MAX: 1 S-100 SLOT 1 MEGABYTE

The MACROTECH MAX is a 256K to 1 Megabyte S-100 IEEE/696 dynamic memory board. That's right, up to 1 Megabyte on a single standard size S-100 board. The first 384K is on the Host card that plugs into your motherboard. The remaining *840K is located on a unique "piggy-*back" card that attaches to the host. The MAX family is ideally suited to applications where density, speed, and software flexibility are essential. See Page 16 Of Our New '83/'84 Engineering Selection Guide for Complete Specifications

Ordering Information: The 256K and 384K versions include the fully socketed Host card. The 512K and larger versions also include the fully socketed "piggy-back" card.

		List Price	SALE Price
BCMACMAX256	256K Dynamic RAM (A&T)	$1125.00	$1165.00
BCMACMAX384	384 Dynamic RAM (A&T)	$1467.00	$1395.00
BCMACMAX512	512K Dynamic RAM (A&T)	$1880.00	$1795.00
BCMACMAXM	1 MEG Dynamic RAM (A&T)	$2449.00	$2325.00
BCMACM3	Memory Mapping Option		$ 91.00

Attention CompuPro CPU 8085/88 Users: You must order the CPU modification hardware to insure complete compatibility.

BCMACBBTMOD	Hardware modification for CompuPro CPU 8085/88	$ [illegible]

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PRIORITY ONE ELECTRONICS

ADD-ONS FOR IBM™ & OTHER PCs!

PRINTERS

star

BDSTRGEMI0X	120 cps, 80 col (20 lbs.)	$399.00	$288.00
BDSTRGEM15X	120 cps, 132 col (26 lbs.)	$649.00	$419.00
BDSTRSERINTX	Serial Interface for 10X and 15X		$ 59.00
BDSTRSERINTX4K	Same as above with 4K Buffer		$119.00
BDSTRDELTA10	160 cps, 80 col. (20 lbs.)	$649.00	$488.00
BDSTRDELTA15	160 cps, 132 col. (20 lbs.)	$799.00	$699.00
BDSTRPOWERTYPE	18 cps Letter Quality (25 lbs.)		$448.00

MANNESMAN-TALLY

'.etter Quality Dot Matrix Printers

[illegible]	160 cps, 80 col. (21 lbs.)	$555
BDTALMT160L	160 cps, 132 col. (28 lbs.)	$829

PRINTER CABLES

BOPGC36CF72CP	Centronics Male to Male 6'	$24.95
BOPGC25DF72CP	IBM PC™ to Centronics Parallel 6'	$34.95
BOPGC251PGP	6' 9 conductor shielded RS-232	$19.95

PRACTICAL PERIPHERALS

PRINTER BUFFERS

MICROBUFFER - Stand Alone Buffer

BDPRPMB1S64	64K Serial	$349.00	$269.00
BDPRPMB1P64	64K Parallel	$349.00	$269.00
BDPRPMEM64	64K Expansion Module	$179.00	$145.00

MICROBUFFER II+ For Apple II/IIe

16K, Expandable to 64K. Extensive Graphics. Serial & Parallel Ports.

BDPRPMB2PLUS16S	w/Serial Cable	$259.00	$169.00
BDPRPMB2PLUS16P	w/Parallel Cable	$259.00	$169.00
BDPRPGRAPHICARD	Graphics Only Card	$ 99.00	$ 85.00
BDPRPPRINTERFACE	Centronics Paralle I/O Card	$ 75.00	$ 59.00

DUFFERS FOR EPSON PRINTERS

Compatible with EPSON MX, FX, RX Series' and IBM Printers

[illegible]	Serial 8K buffer	$159.00	$129.00
[illegible]P16	Parallel 16K buffer	$159.00	$120.00

VIDEO MONITORS

SANYO

12" 80 x 24 18MHz

Part	Description	List Price	Sale Price
BDSYODM8012CX	Black & White Display	$240.00	$149.00
BDSYODM9012CX	B&W w/Audio	$260.00	$165.00
BDSYODM8112CX	Green P31 Display	$240.00	$149.00
BDSYODM9112CX	Green P31 w/Audio	$260.00	$165.00
BDSYODM8212CX	Amber Display	$240.00	$149.00
BDSYODM9212CX	Amber w/Audio	$260.00	$165.0

13" RGB COLOR w/AUDIO

BDSYODM6500	Medium Res. 350	350 lines	$495.00	$349.0
BDSYODM7500	High Res. H480 x	240 dots	$725.00	$499.0
BDSYODM8500	Ultra High H690 :	V240 dots	$1085.00	$799.0

(Shipping Weights on above monitors: 12": 24 lbs. ea / 13" color: 30 lbs. ea.)

TAXAN

12" 80 x 24 18MHz

BDTAXKG12NUY	Amber Display	$189.00	$129.00
BDTAXKG12N	Green Display	$179.00	$110.00

12" RGB COLOR

BDTAXRGB1	Medium Res. 310 lines	$399.00	$349.00
BDTAXRGB3	Super High Res. 630 lines	$699.00	$599.00
BDTAXRGB420	IBM Look-Alike, 630 lines	$699.00	$599.00

15M Byte Hard Disk For IBM PC™

International Instrumentation Incorporated

50% More Capacity Than The XT™!

- Plug and Run—ready to go right out of the box!
- Complete with controller card, data cable, & internal mounting hardware
- Total PC/XT compatible — will boot directly from the hard disk under DOS 2.0™ (Current Model)
- No special software needed
- 8K BIOS emulates XT command set
- Controller will support any 2 hard drives (ST506 Compatible)
- Hard disk can be partitioned into 4 operating systems
- 2:1 interleaving (data transfer rate 3 times faster than XT™)

INTERNAL 10M Byte Hard Disk With Controller

$995

BDIIINOPC110 (Sh. Wt. 11 lbs.)

INTERNAL 15M Byte Hard Disk With Controller

$1395

BDIIINOPC115 (Sh. Wt. 11 lbs.)

EXTERNAL 15M Byte Hard Disk With Controller

The 15Mbyte drive is mounted in a IIIHD5001 cabinet with power supply. All hardware specifications are the same.

$1595

IDPDBIIINOPCX15 (Sh. Wt. 16 lbs.)

External 15 Mbyte ...d Disk w/Controller & Data Cable

MODEMS

U.S. ROBOTICS INC

1200 Baud, Auto Dial/Auto Answer

BDUSRPASSWORD	1200 Baud PASSWORD	$449.00	$349.95
BDUSRADIAL212A	1200 baud with LEDs	$599.00	$450.95
BDUSRS100	1200 Baud S-100 Card	$449.00	$399.00

TELPAC COMMUNICATIONS SOFTWARE

BDUSRTELPACSA	Software on Apple 5¼" Format	$ 79.00
BDUSRTELPAC8	Software on 8" SSSD CP/M® Disk	$ 79.00

D.C. HAYES

BDDCH0400P	1200 Baud Smartmodem	$695.00	$614.95
BDDCH0200P	300 Baud Smartmodem	$279.00	$220.00
BDDCH0300P	Chronograph	$249.00	$189.00
BDDCH0100P	MicroModem 100	$399.00	$349.00
BDDCH0000P	MicroModem II	$379.00	$299.00
BDDCH1200B	IBM-PC™ Modem Card	$599.00	$499.00

RIXON

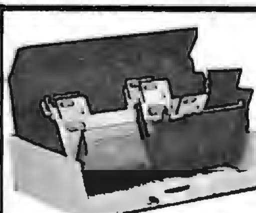
1200 Baud Direct Connect w/10 Number Memory

BDRIXR212A	1200 Baud Stand-Alone Unit	$495.00	$[illegible]
BDRIXPC212A	1200 IBM PC™ Modem (2 lbs.)	$495.00	$[illegible]
BDRIXPCCOM1	IBM PC™ Modem Software (1 lb.)		$[illegible]
BDPDBRIXIBM	IBM Modem & Software Together (3 lbs.)		$539.00

MURA

BDMURMM100	300 Baud Modem (2 lbs.)	$99.95	$79.00

FLIP 'N' FILE



50 Capacity

Stores 50 5¼" Diskettes (9 lbs.)

BBINC03813130

5¼" Double Density, Soft Sector, 40 Track Diskettes

Use with IBM, Sanyo, Apple and Most Personal Computers.

		1		
		2		
		1		
		2		
BDDSN1041D	DYSAN	1	$34.00	$32.00
BDDSN1042D	DYSAN	2	$41.00	$39.00

CALL FOR HARD SECTOR & 77 TRACK DISKS NOT LISTED HERE

8" Double Density, Soft Sector

BDMXLFD1128M1200	MAXELL	1	$44.00	$38.00
BDMXLFD2XDM1200	MAXELL	2	$51.00	$47.00

VISA **PRIORITY ONE ELECTRONICS** MasterCard

9161 Deering Ave., Chatsworth, CA 91311-5887

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DRIVES & ENCLOSURES

5¼" FLOPPY DISK DRIVES

BOMPI51*	MPI Full Height SS 48TPI (5 lbs.)	$200.00
BDMPI52*	MPI Full Height DS 48TPI (5 lbs.)	$270.00
BOMPI91*	MPI Full Height SS 96TPI (5 lbs.)	$275.00
BOMPI92*	MPI Full Height DS 96TPI (5 lbs.)	$400.00
BOMPI501	MPI ½-Height SS 48TPI (4 lbs.)	$280.00
BOMPI502	MPI ½-Height DS 48TPI (4 lbs.)	$300.00
BDTNDTM1001	Tandon Full Height SS 48TPI	$199.00
BOTNDTM1002	Tandon Full Height DS 48TPI	$249.00
BOTNDTM1014	Tandon Full Height DS 96TPI	$339.00

*Rep ace with M for MPI Door, or S for Shugart SA400 Type Door

5¼" Disk Drive Cabinets

BDJMR1C5	Single Drive Cabinet (5 lbs.)	$ 79.00
BDJMR2C5	Dual Drive Cabinet (9 lbs.)	$ 99.00
BDJMR2C5C	Dual w/Internal Data Cable (9 lbs.)	$115.00

8" Floppy Disk Drives

BDSHU801R	Shugart Full Height SS (18 lbs.)	$349.00
BDSHU851R	Shugart Full Height DS (18 lbs.)	$479.00
BDSIEFDD1008	Siemens Full Height SS (18 lbs.)	$149.00
BDQMETRAK842	Qume Full Height DS (18 lbs.)	$459.00
BDMITM2894638	Mitsubishi Full Height DS (18 lbs.)	$375.00
BOMPI41S	MPI Full Height SS (11 lbs.)	$380.00
BOMPI42S	MPI Full Height DS (11 lbs.)	$480.00
BOMPI410	MPI Dual ½-Height SS (22 lbs.)	$760.00
BOMPI420	MPI Dual ½-Height DS (22 lbs.)	$830.00
BOMPI41M	MPI ½-Height SS (9 lbs.)	$380.00
BOMPI42M	MPI ½-Height DS (9 lbs.)	$480.00
BOTNDTM8481	Tandon ½-Height SS (9 lbs.)	$359.00
BOTNDTM8482	Tandon ½-Height DS (9 lbs.)	$435.00

Dual 8" Disk Enclosures

All of these rugged enclosures feature forced, filtered air cooling, hefty power supply, with the heat producing elements mounted to outside for cool, reliable operation. The rear panels are punched for the appropriate data cables.

FDE002. Economical design for two standard size 8" floppies. Hinged lid for easy drive access. Power supply: 5V@4A, -5V@.8A, +24@3A.

DTL002. Cabinet for two ½-height 8" drives or 1 full height 8" floppy or Winchester. Includes Shugart type AC power cable.

Part Number	Description	List Price	SALE Price
BOIIIFDE002	FDE002 Dual Enc. (35 lbs.)	$359.95	$325.00
BOIIIDTL002SHU	DTL002 Dual Thin Line (12 lbs.)	$225.00	$175.00
BDIIIDTLMPIKIT	MPI ½-Height DTL adapter kit		$ 24.95
BDIIICBLSQN304FM	Shugart to Qume AC Cable		$ 4.95

BUY CABINETS WITH DRIVES AND $AVE!

Combinations with FOED02

BOPDBIIIFDE2S2	w/2 SHU801R Drives	[illegible]
BOPDBIIIFDE2M2	w/2 MFM289463BS Drives	$1049.00
BDPDBIIIFDE2Q2	w/2 QMETRAK842 Drives	$1199.00
BOPDBIIIFDE2851	w/2 SHU851R Drives	$1239.00
BOPDBIIISIE	w/2FDD1008 Drives	$ 499.00

Combinations with DTL002

BOPDBIIITN01	w/2 TNDTM8481 Drives	$ 879.00
BOPDBIIITN02	w/2 TNDTM8482 Drives	$1039.00
BOPDBIIIMPI1	w/2 MPI41 M Drives	$ 879.00
BDPDBIIIMPI2	w/2 MPI42M Drives	$1039.00

Due to UPS Regulations, drives and cabinets will be shipped separately. Please include shipping for each disk drive and cabinet.

5¼" Hard Disk

BOMCP1302	Micropolis 20.4/25.9 Mb (12 lbs.)	$1485.00
BOMCP1303	Micropolis 33.9/43.2 Mb (12 lbs.)	$1875.00
BOTNDTM501	Tandon 6 Mb (9 lbs.)	$ 899.00
BOTNDTM502	Tandon 12 Mb (9 lbs.)	$ 849.00
BOTNDTM503	Tandon 19 Mb (9 lbs.)	$ 995.00

DUAL 5¼" HARD DISK DRIVE CABINET

Alll of the necessary power for two TANDDN TM500 series or equivalent *hard disk drives. Just imagine, you can have* 100Mbytes of storage using two of the Micropolis 5¼" Winchester disk drives and this cabinet! Power supply: +5V@6A and +12V@6A. The rear panel is punched for two 20, two 34, and one 50 pin header connector. Fan cooled.

BBIIIHD5002 Dual Hard Disk Enclosure (Sh. Wt. 20 lbs) $389.00

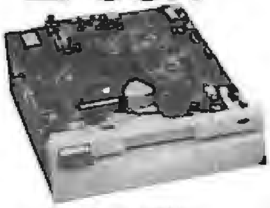
BUY CABINET WITH DRIVES AND $AVE!

BDPDB501HD5	w/2 TM501 Drives	$1599.00
BDPDB502HD5	w/2 TM502 Drives	$1899.00
BDPDB503HD5	w/2 TM503 Drives	$2149.00
BDPDB1302HD5	w/2 MCP1302 Drives	$2999.00
BDPDB1303HD5	w/2 MCP1303 Drives	$3799.00
BDPDB1304HD5	w/2 MCP1304 Drives	$4399.00

Due to UPS Regulations, disk drives will be shipped separately from cabinets. Don't forget to include shipping for each disk drive cabinet.

ADD ON DRIVES FOR IBM PC™

EPSON



HALF HEIGHT 5¼" 40 TRACK 48 TPI

DOUBLE SIDED

$189

BDEPN521 (Sh. Wt. 4 lbs.)

JMR

5¼" FLOPPY CABINET

Holds 2 Half- or 1 Full-Height Drive - Power Supply Included

$69

BDJMR2SV5 (Sh. Wt. 7 lbs.)

Tandon

TM100-2 FULL HEIGHT 5¼" 40 TRACK 48 TPI

$219

DOUBLE SIDED

BDTNDTM1002 (Sh. Wt. 4 lbs.)

International Instrumentation Incorporated — MICROPOLIS

UP TO 104M BYTES IN ONE CABINET!

52M Byte Drive In A Single Drive Cabinet

$2295.00

BDPDB1304HD51

Two 52M Byte Drives In A Dual Drive Cabinet

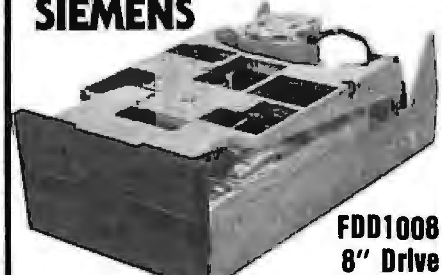
$4390.00

BDPDB1304HD5

Sold Separately:

BDMCP1304	Micropolis 40.8/51.9 Mb (12 lbs.)	$2195.00
BDIIIHD5002	Dual hard Disk Enclosure (20 lbs.)	$389.00
BDIIIHD5001	Hard Disk Enclosure (16 lbs.)	$299.00

SIEMENS



FDD1008 8" Drive Single Sided Double Density

$149.00 each

DUAL SIEMENS FDD1008s With IIIFDE002 Cabinet

$499.00

BDPDBIIISIE

NOW! The Affordable UPS For Your Personal Computer!

$359.00

200 Watts For 5 Minutes of Uninterruptable Power With AC Surge and EMI/RFI Filtering Built-In!

Perfect for Morrow Micro Decision, IBM PC™, Apple IIe, and many, many more!

BDPTIPC200 (Sh. Wt. 21 lbs.) $359.00

Circle 301 on inquiry card.

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Terms U.S. VISA, MC, BAC, Check, Money Order, U.S. Funds Only. CA residents add 6½% Sales Tax. MINIMUM PREPAID ORDERS $15.00. Include MINIMUM SHIPPING & HANDLING of $3.00 for the first 3 lbs. plus 40¢ for each additional pou . Orders over 70 lbs. sent freight collect. Just in case, include your phone number. Prices subject to change without notice. We will do our best to maintain prices through April, 1984. Credit card orders will be charged appropriate freight. We are not responsible for typographical errors. Sale prices for prepaid orders only.

ORDER TOLL FREE (800) 423-5922 - CA, AK, HI CALL (818) 709-5111

4164 64K DYNAMIC 200 NS $5.95 TMM2016 2KX8 STATIC 200 NS $4.15

STATIC RAMS

2101	256 x 4	(450ns)	1.95
5101	256 x 4	(450ns) (cmos)	3.95
2102-1	1024 x 1	(450ns)	.89
2102L-4	1024 x 1	(450ns) (LP)	.99
2102L-2	1024 x 1	(250ns) (LP)	1.49
2111	256 x 4	(450ns)	2.49
2112	256 x 4	(450ns)	2.99
2114	1024 x 4	(450ns)	8/9.95
2114-25	1024 x 4	(250ns)	8/10.95
2114L-4	1024 x 4	(450ns) (LP)	8/12.95
2114L-3	1024 x 4	(300ns) (LP)	8/13.45
2114L-2	1024 x 4	(200ns) (LP)	8/13.95
TC5514	1024 x 4	(650ns) (cmos)	2.49
TC5516	2048 x 8	(250ns) (cmos)	9.95
2147	4096 x 1	(55ns)	4.95
TMS4044-4	4096 x 1	(450ns)	3.49
TMS4044-3	4096 x 1	(300ns)	3.99
TMS4044-2	4096 x 1	(200ns)	4.49
MK4118	1024 x 8	(250ns)	9.95
TMM2016-200	2048 x 8	(200ns)	4.15
TMM2016-150	2048 x 8	(150ns)	4.95
TMM2016-100	2048 x 8	(100ns)	6.15
HM6116-4	2048 x 8	(200ns) (cmos)	4.75
HM6116-3	2048 x 8	(150ns) (cmos)	4.95
HM6116-2	2048 x 8	(120ns) (cmos)	8.95
HM6116LP-4	2048 x 8	(200ns) (cmos)(LP)	5.95
HM6116LP-3	2048 x 8	(150ns) (cmos)(LP)	6.95
HM6116LP-2	2048 x 8	(120ns) (cmos)(LP)	10.95
Z-6132	4096 x 8	(300ns) (Qstat)	34.95
HM6264	8192 x 8	(150ns) (cmos)	49.95

LP = Low Power Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1	(250ns)	1.99
UPD411	4096 x 1	(300ns)	3.00
MM5280	4096 x 1	(300ns)	3.00
MK4108	8192 x 1	(200ns)	1.95
MM5298	8192 x 1	(250ns)	1.85
4116-300	16384 x 1	(300ns)	8/11.75
4116-250	16384 x 1	(250ns)	8/7.95
4116-200	16384 x 1	(200ns)	8/12.95
4116-150	16384 x 1	(150ns)	8/14.95
4116-120	16384 x 1	(120ns)	8/29.95
2118	16384 x 1	(150ns) (5v)	4.95
MK4332	32768 x 1	(200ns)	9.95
4164-200	65536 x 1	(200ns) (5v)	5.95
4164-150	65536 x 1	(150ns) (5v)	6.95
MCM6665	65536 x 1	(200ns) (5v)	8.95
TMS4164-15	65536 x 1	(150ns) (5v)	8.95

5V = single 5 volt supply

EPROMS

1702	256 x 8	(1us)	4.50
2708	1024 x 8	(450ns)	3.95
2758	1024 x 8	(450ns) (5v)	5.95
2716	2048 x 8	(450ns) (5v)	3.95
2716-1	2048 x 8	(350ns) (5v)	5.95
TMS2516	2048 x 8	(450ns) (5v)	5.50
TMS2716	2048 x 8	(450ns)	7.95
TMS2532	4096 x 8	(450ns) (5v)	5.95
2732	4096 x 8	(450ns) (5v)	4.95
2732-250	4096 x 8	(250ns) (5v)	8.95
2732-200	4096 x 8	(200ns) (5v)	11.95
2732A-4	4096 x 8	(450ns) (5v) (21vPGM)	6.95
2732A	4096 x 8	(250ns) (5v) (21vPGM)	9.95
2732A-2	4096 x 8	(200ns) (5v) (21vPGM)	13.95
2764	8192 x 8	(450ns) (5v)	6.95
2764-250	8192 x 8	(250ns) (5v)	7.95
2764-200	8192 x 8	(200ns) (5v)	19.95
TMS2564	8192 x 8	(450ns) (5v)	14.95
MCM68764	8192 x 8	(450ns) (5v) (24 pin)	39.95
MCM68766	8192 x 8	(350ns) (5v) (24 pin)(pwr dn.)	42.95
27128	16384 x 8	(300ns) (5v)	29.95

5v = Single 5 Volt Supply 21vPGM = Program at 21 Volts

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HM6264 HITACHI 8K x 8 STATIC RAM

- Fast—150 ns • +5V Supply
- 28 Pin—Compatible w/2764 EPROM
- Low Power CMOS (TTL Compatible) 200 mW Operation/.01 mW Standby (LP)

HM6264P-15 $39.95 HM6264LP-15 $49.95

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- ★ Friendly staff!
- ★ Fast service — most orders shipped within 24 hours!

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32.768 khz	1.95
1.0 mhz	3.95
1.8432	3.95
2.0	2.95
2.097152	2.95
2.4576	2.95
3.2768	2.95
3.579545	2.95
4.0	2.95
5.0	2.95
5.0688	2.95
5.185	2.95
5.7143	2.95
6.0	2.95
6.144	2.95
6.5536	2.95
8.0	2.95
10.0	2.95
10.738635	2.95
14.31818	2.95
15.0	2.95
16.0	2.95
17.430	2.95
18.0	2.95
18.432	2.95
20.0	2.95
22.1184	2.95
32.0	2.95

UARTS

AY3-1014	6.95
AY5-1013	3.95
AY3-1015	6.95
PT1472	9.95
TR1602	3.95
2350	9.95
2651	8.95
IM6402	7.95
IM6403	8.95
INS8250	10.95

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BIT-RATE

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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

CMOS

4000	.29	4528	1.19
4001	.25	4531	.95
4002	.25	4532	1.95
4006	.89	4538	1.95
4007	.29	4539	1.95
4008	.95	4541	2.64
4009	.39	4543	1.19
4010	.45	4553	5.79
4011	.25	4555	.95
4012	.25	4556	.95
4013	.38	4581	1.95
4014	.79	4582	1.95
4015	.39	4584	.75
4016	.39	4585	.75
4017	.69	4702	12.95
4018	.79	74C00	.35
4019	.39	74C02	.35
4020	.75	74C04	.35
4021	.79	74C08	.35
4022	.79	74C10	.35
4023	.29	74C14	.59
4024	.65	74C20	.35
4025	.29	74C30	.35
4026	1.65	74C32	.39
4027	.45	74C42	1.29
4028	.69	74C48	1.99
4029	.79	74C73	.65
4030	.39	74C74	.65
4034	1.95	74C76	.80
4035	.85	74C83	1.95
4040	.75	74C85	1.95
4041	.75	74C86	.39
4042	.69	74C89	4.50
4043	.85	74C90	1.19
4044	.79	74C93	1.75
4046	.85	74C95	.99
4047	.95	74C107	.89
4049	.35	74C150	5.75
4050	.35	74C151	2.25
4051	.79	74C154	3.25
4053	.79	74C157	1.75
4060	.89	74C160	1.19
4066	.39	74C161	1.19
4068	.39	74C162	1.19
4069	.29	74C163	1.19
4070	.35	74C164	1.39
4071	.29	74C165	2.00
4072	.29	74C173	.79
4073	.29	74C174	1.19
4075	.29	74C175	1.19
4076	.79	74C192	1.49
4078	.29	74C193	1.49
4081	.29	74C195	1.39
4082	.29	74C200	5.75
4085	.95	74C221	1.75
4086	.95	74C244	2.25
4093	.49	74C373	2.45
4098	2.49	74C374	2.45
4099	1.95	74C901	.39
14409	12.95	74C902	.85
14410	12.95	74C903	.85
14411	11.95	74C905	10.95
14412	12.95	74C906	.95
14419	7.95	74C907	1.00
14433	14.95	74C908	2.00
4502	.95	74C909	2.75
4503	.65	74C910	9.95
4508	1.95	74C911	8.95
4510	.85	74C912	8.95
4511	.85	74C914	1.95
4512	.85	74C915	1.19
4514	1.25	74C918	2.75
4515	1.79	74C920	17.95
4516	1.55	74C921	15.95
4518	.89	74C922	4.49
4519	.39	74C923	4.95
4520	.79	74C925	5.95
4522	1.25	74C926	7.95
4526	1.25	74C928	7.95
4527	1.95	74C929	19.95

6800

68000	49.95
6800	2.95
6802	7.95
6803	19.95
6808	13.90
6809E	14.95
6809	11.95
6810	2.95
6820	4.35
6821	2.95
6828	14.95
6840	12.95
6843	34.95
6844	25.95
6845	14.95
6847	11.95
6850	3.25
6852	5.75
6860	7.95
6875	6.95
6880	2.25
6883	22.95
68047	24.95
68488	19.95

6800 = 1MHZ

68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	6.95
68B21	6.95
68B40	19.95
68B45	19.95
68B50	5.95

68B00 = 2 MHZ

6500

1 MHZ

6502	4.95
6504	6.95
6505	8.95
6507	9.95
6520	4.35
6522	6.95
6532	9.95
6545	22.50
6551	11.85

2 MHZ

6502A	6.95
6522A	9.95
6532A	11.95
6545A	27.95
6551A	11.95

3 MHZ

6502B	9.95

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2791	54.95
2793	54.95
2795	59.95
2797	59.95
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6845	14.95
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HD46505SP	15.95
6847	11.95
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8275	29.95
7220	99.95
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DP8350	49.95

8200

8202	24.95
8203	39.95
8205	3.50
8212	1.80
8214	3.85
8216	1.75
8224	2.25
8226	1.80
8228	3.49
8237	19.95
8237-5	21.95
8238	4.49
8243	4.45
8250	10.95
8251	4.49
8253	6.95
8253-5	7.95
8255	4.49
8255-5	5.25
8257	7.95
8257-5	8.95
8259	6.90
8259-5	7.50
8271	79.95
8272	39.95
8275	29.95
8279	8.95
8279-5	10.00
8282	6.50
8283	6.50
8284	5.50
8286	6.50
8287	6.50
8288	25.00
8289	49.95

Z-80

2.5 Mhz

Z80-CPU	3.95
Z80-CTC	3.95
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Z80-SIO/0	11.95
Z80-SIO/1	11.95
Z80-SIO/2	11.95
Z80-SIO/9	11.95

4.0 Mhz

Z80A-CPU	4.49
Z80A-CTC	4.95
Z80A-DART	9.95
Z80A-DMA	12.95
Z80A-PIO	4.49
Z80A-SIO/0	12.95
Z80A-SIO/1	12.95
Z80A-SIO/2	12.95
Z80A-SIO/9	12.95

6.0 Mhz

Z80B-CPU	9.95
Z80B-CTC	12.95
Z80B-PIO	12.95
Z80B-DART	19.95
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74LS00

74LS00	.24	74LS173	.69
74LS01	.25	74LS174	.55
74LS02	.25	74LS175	.55
74LS03	.25	74LS181	2.15
74LS04	.24	74LS189	8.95
74LS05	.25	74LS190	.89
74LS08	.28	74LS191	.89
74LS09	.29	74LS192	.79
74LS10	.25	74LS193	.79
74LS11	.35	74LS194	.69
74LS12	.35	74LS195	.69
74LS13	.45	74LS196	.79
74LS14	.59	74LS197	.79
74LS15	.35	74LS221	.89
74LS20	.25	74LS240	.95
74LS21	.29	74LS241	.99
74LS22	.25	74LS242	.99
74LS26	.29	74LS243	.99
74LS27	.29	74LS244	1.29
74LS28	.35	74LS245	1.49
74LS30	.25	74LS247	.75
74LS32	.29	74LS248	.99
74LS33	.55	74LS249	.99
74LS37	.35	74LS251	.59
74LS38	.35	74LS253	.59
74LS40	.25	74LS257	.59
74LS42	.49	74LS258	.59
74LS47	.75	74LS259	2.75
74LS48	.75	74LS260	.59
74LS49	.75	74LS266	.55
74LS51	.25	74LS273	1.49
74LS54	.29	74LS275	3.35
74LS55	.29	74LS279	.49
74LS63	1.25	74LS280	1.98
74LS73	.39	74LS283	.69
74LS74	.35	74LS290	.89
74LS75	.39	74LS293	.89
74LS76	.39	74LS295	.99
74LS78	.49	74LS298	.89
74LS83	.60	74LS299	1.75
74LS85	.69	74LS323	3.50
74LS86	.39	74LS324	1.75
74LS90	.55	74LS352	1.29
74LS91	.89	74LS353	1.29
74LS92	.55	74LS363	1.35
74LS93	.55	74LS364	1.95
74LS95	.75	74LS365	.49
74LS96	.89	74LS366	.49
74LS107	.39	74LS367	.45
74LS109	.39	74LS368	.45
74LS112	.39	74LS373	1.39
74LS113	.39	74LS374	1.39
74LS114	.39	74LS375	.95
74LS122	.45	74LS377	1.39
74LS123	.79	74LS378	1.18
74LS124	2.90	74LS379	1.35
74LS125	.49	74LS385	3.90
74LS126	.49	74LS386	.45
74LS132	.59	74LS390	1.19
74LS133	.59	74LS393	1.19
74LS136	.39	74LS395	1.19
74LS137	.99	74LS399	1.49
74LS138	.55	74LS424	2.95
74LS139	.55	74LS447	.95
74LS145	1.20	74LS490	1.95
74LS147	2.49	74LS624	3.99
74LS148	1.35	74LS640	2.20
74LS151	.55	74LS645	2.20
74LS153	.55	74LS668	1.69
74LS154	1.90	74LS669	1.89
74LS155	.69	74LS670	1.49
74LS156	.69	74LS674	14.95
74LS157	.65	74LS682	3.20
74LS158	.59	74LS683	3.20
74LS160	.69	74LS684	3.20
74LS161	.65	74LS685	3.20
74LS162	.69	74LS688	2.40
74LS163	.65	74LS689	3.20
74LS164	.69	81LS95	1.49
74LS165	.95	81LS96	1.49
74LS166	1.95	81LS97	1.49
74LS168	1.75	81LS98	1.49
74LS169	1.75	25LS2521	2.80
74LS170	1.49	25LS2569	4.25

74S00

74S00	.32	74S132	1.24	74S225	7.95
74S02	.35	74S133	.45	74S240	2.20
74S03	.35	74S134	.50	74S241	2.20
74S04	.35	74S135	.89	74S244	2.20
74S05	.35	74S138	.85	74S251	.95
74S08	.35	74S139	.85	74S253	.95
74S09	.40	74S140	.55	74S257	.95
74S10	.35	74S151	.95	74S258	.95
74S11	.35	74S153	.95	74S260	.79
74S15	.35	74S157	.95	74S273	2.45
74S20	.35	74S158	.95	74S274	19.95
74S22	.35	74S161	1.95	74S275	19.95
74S30	.35	74S162	1.95	74S280	1.95
74S32	.40	74S163	1.95	74S287	1.90
74S37	.88	74S168	3.95	74S288	1.90
74S38	.85	74S169	3.95	74S289	6.89
74S40	.35	74S174	.95	74S301	6.95
74S51	.35	74S175	.95	74S373	2.45
74S64	.40	74S181	3.95	74S374	2.45
74S65	.40	74S182	2.95	74S381	7.95
74S74	.50	74S188	1.95	74S387	1.95
74S85	1.99	74S189	6.95	74S412	2.98
74S86	.50	74S194	1.49	74S471	4.95
74S112	.50	74S195	1.49	74S472	4.95
74S113	.50	74S196	1.49	74S474	4.95
74S114	.55	74S197	1.49	74S482	15.25
74S124	2.75	74S201	6.95	74S570	2.95
				74S571	2.95

VOLTAGE REGULATORS

7805T	.75	7905T	.85
78M05C	.35	7908T	.85
7808T	.75	7912T	.85
7812T	.75	7915T	.85
7815T	.75	7924T	.85
7824T	.75	7905K	1.49
7805K	1.39	7912K	1.49
7812K	1.39	7915K	1.49
7815K	1.39	7924K	1.49
7824K	1.39	79L05	.79
78L05	.69	79L12	.79
78L12	.69	79L15	.79
78L15	.69	LM323K	4.95
78H05K	9.95	UA78S40	1.95
78H12K	9.95		

C, T = TO-220   K = TO-3
L = TO-92

SOUND CHIPS

76477	3.95	AY3-8910	12.95
76488	5.95	AY3-8912	12.95
76489	8.95	MC3340	1.49

7400

7400	.19	74123	.49
7401	.19	74125	.45
7402	.19	74126	.45
7403	.19	74132	.45
7404	.19	74136	.50
7405	.25	74143	4.95
7406	.29	74145	.60
7407	.29	74147	1.75
7408	.24	74148	1.20
7409	.19	74150	1.35
7410	.19	74151	.55
7411	.25	74153	.55
7413	.35	74154	1.25
7414	.49	74155	.75
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.69
7425	.29	74163	.69
7427	.29	74164	.85
7430	.19	74165	.85
7432	.29	74166	1.00
7437	.29	74167	2.95
7438	.29	74170	1.65
7442	.49	74173	.75
7445	.69	74174	.89
7446	.69	74175	.89
7447	.69	74177	.75
7448	.69	74181	2.25
7451	.23	74184	2.00
7473	.34	74185	2.00
7474	.33	74191	1.15
7475	.45	74192	.79
7476	.35	74193	.79
7482	.95	74194	.85
7483	.50	74195	.85
7485	.59	74197	.75
7486	.35	74198	1.35
7489	2.15	74221	1.35
7490	.35	74246	1.35
7492	.50	74247	1.25
7493	.35	74259	2.25
7495	.55	74273	1.95
7497	2.75	74276	1.25
74100	1.75	74279	.75
74107	.30	74366	.65
74109	.45	74367	.65
74116	1.55	74368	.65
74121	.29	74393	1.35
74122	.45		

BYPASS CAPS

.01 UF DISC	100/6.00
.01 UF MONOLITHIC	100/12.00
.1 UF DISC	100/8.00
.1 UF MONOLITHIC	100/15.00

EPROM ERASERS

SPECTRONICS CORPORATION

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		9	8,000	83.00
PE-14T	X	9	8,000	119.00
PE-24T	X	12	9,600	175.00
PL-265T	X	30	9,600	255.00
PR-125T	X	25	17,000	349.00
PR-320T	X	42	17,000	595.00

INTERFACE

8T26	1.59
8T28	1.89
8T95	.89
8T96	.89
8T97	.89
8T98	.89
DM8131	2.95
DP8304	2.29
DS8833	2.25
DS8835	1.99
DS8836	.99
DS8837	1.65
DS8838	1.30

VISA

MasterCard

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

CONNECTORS

RS232 Male	2.50
RS232 Female	3.25
RS232 Hood	1.25
S-100 ST	3.95

EXAR

XR 2206	3.75
XR 2207	3.75
XR 2208	3.75
XR 2211	5.25
XR 2240	3.25

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

LINEAR

LM301	.34	LM340 (see 7800)		LM565	.99	LM1558H	3.10
LM301H	.79	LM348	.99	LM566	1.49	LM1800	2.37
LM307	.45	LM350K	4.95	LM567	.89	LM1812	8.25
LM308	.69	LM350T	4.60	NE570	3.95	LM1830	3.50
LM308H	1.15	LM358	.69	NE571	2.95	LM1871	5.49
LM309H	1.95	LM359	1.79	NE590	2.50	LM1872	5.49
LM309K	1.25	LM376	3.75	NE592	2.75	LM1877	3.25
LM310	1.75	LM377	1.95	LM709	.59	LM1889	1.95
LM311	.64	LM378	2.50	LM710	.75	LM1896	1.75
LM311H	.89	LM379	4.50	LM711	.79	ULN2003	2.49
LM312H	1.75	LM380	.89	LM723	.49	LM2877	2.05
LM317K	3.95	LM380N-8	1.10	LM723H	.55	LM2878	2.25
LM317T	1.19	LM381	1.60	LM733	.98	LM2900	.85
LM318	1.49	LM382	1.60	LM741	.35	LM2901	1.00
LM318H	1.59	LM383	1.95	LM741N-14	.35	LM3900	.59
LM319H	1.90	LM384	1.95	LM741H	.40	LM3905	1.25
LM319	1.25	LM386	.89	LM747	.69	LM3909	.98
LM320 (see 7900)		LM387	1.40	LM748	.59	LM3911	2.25
LM322	1.65	LM389	1.35	LM1014	1.19	LM3914	3.95
LM323K	4.95	LM390	1.95	LM1303	1.95	LM3915	3.95
LM324	.59	LM392	.69	LM1310	1.49	LM3916	3.95
LM329	.65	LM393	1.29	MC1330	1.69	MC4024	3.95
LM331	3.95	LM394H	4.60	MC1349	1.89	MC4044	4.50
LM334	1.19	LM399H	5.00	MC1350	1.19	RC4136	1.25
LM335	1.40	NE531	2.95	MC1358	1.69	RC4151	3.95
LM336	1.75	NE555	.34	MC1372	6.95	LM4250	1.75
LM337K	3.95	NE556	.65	LM1414	1.59	LM4500	3.25
LM337T	1.95	NE558	1.50	LM1458	.59	RC4558	.69
LM338K	6.95	NE561	24.95	LM1488	.69	LM13080	1.29
LM339	.99	NE564	2.95	LM1489	.69	LM13600	1.49
				LM1496	.85	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		

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I tell all my computer owning friends about the "good guys" at JDR.
Your service is appreciated, and I am sure, pays off in the long run.

Your customer,
Evan H. Foreman

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2716 16K EPROMS $3.95 EA

4116 250 NS 8/$7.95

BARGAIN HUNTERS CORNER

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DB25P	25 PIN MALE	10/19.95
DB25S	25 PIN FEMALE	10/24.95
HOOD25	GREY HOOD	10/9.95

CENTRONICS CONNECTORS

CEN36	36 PIN MALE	5.95

IC SOCKETS

14 PIN	ST LOW PROFILE	100/7.95
16 PIN	ST LOW PROFILE	100/7.95

SPECIALS END 5/31/84

RF MODULATOR

(ASTEC UM1082) QUANTITIES LIMITED

- ★ PRESET TO CHANNEL 3
- ★ USE TO BUILD TV-COMPUTER INTERFACE
- ★ +5 VOLT OPERATION

NOW ONLY $6.95

CAPACITORS

TANTALUM

	6V	10V	15V	20V	25V	35V
.22uf						.40
.27						.40
.33						.40
.47				.35		.50
.68						.45
1.0			.40	.40	.45	.45
1.5				.45		.50
1.8						.75
2.2		.35	.40	.45		.65
2.7		.40	.45			.90
3.3		.45	.50	.55	.60	.65
3.9		.45				
4.7	.45	.55		.60	.65	.85
6.8			.70		.75	
8.2						1.00
10	.55	.65	.80	.85	.90	1.00
12	.65		.85	.90		
15	.75	.85	.90			
18			1.25			
22		1.00	1.35			
27			2,25			
39		1.50				
47	1.35					
56	1.75					
100		3.25				
270	3.75					

DISC

10pf	50V	.05	470	50V	.05
22	50V	.05	560	50V	.05
25	50V	.05	680	50V	.05
27	50V	.05	820	50V	.05
33	50V	.05	.001uf	50V	.05
47	50V	.05	.0015	50V	.05
56	50V	.05	.0022	50V	.05
68	50V	.05	.005	50V	.05
82	50V	.05	.01	50V	.07
100	50V	.05	.02	50V	.07
220	50V	.05	.05	50V	.07
330	50V	.05	.1	12V	.10
			.1	50V	.12

MONOLITHIC

.1uf-mono	50V	.18	.47uf-mono	50V	.25
.047uf-mono	50V	.15	.01uf-mono	50V	.14

ELECTROLYTIC

RADIAL			AXIAL		
.47uf	50V	.14	1uf	50V	.14
1	25V	.14	4.7	16V	.14
2.2	35V	.15	10	16V	.14
4.7	50V	.15	10	50V	.16
10	50V	.15	22	16V	.14
47	35V	.18	47	50V	.20
100	16V	.18	100	15V	.20
220	35V	.20	100	35V	.25
470	25V	.30	150	25V	.25
2200	16V	.60	220	25V	.30
			330	16V	.40
			500	16V	.42
			1000	16V	.60
			1500	16V	.70
			6000	16V	.85

COMPUTER GRADE

26,000uf 30V 3.95

OPTO-ISOLATORS

4N26	1.00	MCA-7	4.25
4N27	1.10	MCA-255	1.75
4N28	.69	IL-1	1.25
4N33	1.75	ILA-30	1.25
4N35	1.25	ILQ-74	2.75
4N37	1.25	H11C5	1.25
MCT-2	1.00	TIL-111	1.00
MCT-6	1.50	TIL-113	1.75

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WE HAVE THE COMPLETE LINE OF DISC. TANTALUM AND ELECTROLYTIC CAPACITORS IN STOCK!

IC SOCKETS

	1-99	100
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
64 pin ST	4.25	call
ST = SOLDERTAIL		
8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80
WW = WIREWRAP		
16 pin ZIF	5.95	call
24 pin ZIF	7.95	call
28 pin ZIF	8.95	call
ZIF = TEXTOOL (Zero Insertion Force)		

DIODES

1N751	5.1 volt zener	.25
1N759	12.0 volt zener	.25
1N4148	(1N914) switching	25/1.00
1N4004	400PIV rectifier	10/1.00
KBP02	200PIV 1.5amp bridge	.45
KBP04	400PIV 1.5amp bridge	.55
VM48	Dip-Bridge	.35

TRANSISTORS

2N918	.50	MPS3706	.15
MPS918	.25	2N3772	1.85
2N2102	.75	2N3903	.25
2N2218	.50	2N3904	.10
2N2218A	.50	2N3906	.10
2N2219	.50	2N4122	.25
2N2219A	.50	2N4123	.25
2N2222	.25	2N4249	.25
PN2222	.10	2N4304	.75
MPS2369	.25	2N4401	.25
2N2484	.25	2N4402	.25
2N2905	.50	2N4403	.25
2N2907	.25	2N4857	1.00
PN2907	.125	PN4916	.25
2N3055	.79	2N5086	.25
3055T	.69	PN5129	.25
2N3393	.30	PN5139	.25
2N3414	.25	2N5209	.25
2N3563	.40	2N6028	.35
2N3565	.40	2N6043	1.75
PN3565	.25	2N6045	1.75
MPS3638	.25	MPS-A05	.25
MPS3640	.25	MPS-A06	.25
PN3643	.25	MPS-A55	.25
PN3644	.25	TIP29	.65
MPS3704	.15	TIP31	.75
		TIP32	.79

LED DISPLAYS

HP 5082-7760	.43"	CC	1.29
MAN 72	.3"	CA	.99
MAN 74	.3"	CC	.99
FND-357 (359)	.375"	CC	1.25
FND-500 (503)	.5"	CC	1.49
FND-507 (510)	.5"	CA	1.49
TIL-311 4x7	.270"	HEX W/LOGIC	9.95

LED LAMPS

	1-99	100-up
JUMBO RED	.10	.09
JUMBO GREEN	.18	.15
JUMBO YELLOW	.18	.15
LED MOUNTING HARDWARE	.10	.09

NEW UN-USED MUFFIN FANS

4.68" Square	14.95
3.125" Square	14.95

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TO-3 style	.95
TO-220 style	.35

SWITCHES

SPDT mini-toggle	1.25
DPDT mini-toggle	1.50
SPST mini-pushbutton	.39

RESISTORS

¼ WATT 5% CARBON FILM ALL STANDARD VALUES FROM 1 OHM TO 10 MEG OHM

50 PCS. SAME VALUE	.025
100 PCS. SAME VALUE	.02
1000 PCS. SAME VALUE	.015

DIP SWITCHES

4 POSITION	.85
5 POSITION	.90
6 POSITION	.90
7 POSITION	.95
8 POSITION	.95

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TERMS: Minimum order $10. For shipping and handling include $2.50 for UPS Ground and $3.50 for UPS Air. Orders over 1 lb. and foreign orders may require additional shipping charges — please contact our sales department for the amount. CA residents must include 6% sales tax, Bay Area and LA residents include 6½%. Prices subject to change without notice. We are not responsible for typographical errors. We reserve the right to limit quantities and to substitute manufacturer. All merchandise subject to prior sale.

Circle 206 on inquiry card

2732 32K EPROM $4.95 — 2764 64K EPROM $6.95

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FROM ELCOMP — $14.95

Over 800 pages of manufacturers data sheets on most commonly used IC's.

Includes:
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* CMOS
* Voltage Regulators
* Memory — RAM, ROM, EPROM
* CPU's — 6800, 6500, Z80, 8080, 8085, 8086/8
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DISK DRIVES

TANDON

TM100-1	5¼" (FOR IBM) SS/DD	229.00
TM100-2	5¼" (FOR IBM) DS/DD	259.00

SHUGART

SA 400L	5¼" (40 TRACK) SS/DD	199.95
SA 400	5¼" (35 TRACK) SS/DD	189.95

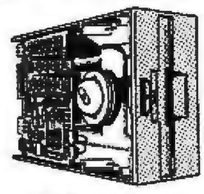
PERTEC

FD-200	5¼" SS/DD	179.95
FD-250	5¼" DS/DD	199.95

MPI

MP-52	5¼" (FOR IBM) DS/DD	249.00

NOTE: Please include sufficient amount for shipping on above items.



8-INCH DISK DRIVE SALE

FD 100-8 — SHUGART 801 EQUIV. SS/DD — 10/$175 EA. — **$189.00**

FD 200-8 — SHUGART 851 EQUIV. DS/DD — 10/$220 EA. — **$239.00**

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Apple II User's Guide	16.95
CRT Controller's Handbook	9.95
68000 Assembly Language Programming	16.99
CBASIC User Guide	15.00

SYBEX

Your First Computer	8.95
The CP/M Handbook	14.95
The PASCAL Handbook	18.95
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S-100 ST	3.95
S-100 WW	4.95
72 pin ST	6.95
72 pin WW	7.95
50 pin ST	4.95
44 pin ST	2.95
44 pin WW	4.95

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CABINETS FOR 5¼" DISK DRIVES

CABINET #1 $29.95
* DIMENSIONS 8⅝ x 5¹⁵⁄₁₆ x 3¹⁵⁄₁₆"
* COLOR MATCHES APPLE
* FITS STANDARD 5¼" DRIVES, INCL. SHUGART
* INCLUDES MOUNTING HARDWARE AND FEET

NOTE: Please include sufficient amount for shipping on above items.

CABINET #2 $79.00
* COMPLETE WITH POWER SUPPLY, SWITCH, LINE CORD, FUSE & STANDARD POWER CONNECTOR
* DIMENSIONS: 11½ x 5¾ x 3¹⁵⁄₁₆"
* +5V @ 1 AMP, +12V @ 1.5 AMP
* FITS STANDARD 5¼" DRIVES
* PLEASE **SPECIFY** GRAY OR TAN

TRANSFORMERS

FRAME STYLE

12.6VAC	2amp	4.95
12.6VAC CT	2amp	5.95
12.6VAC CT	4amp	7.95
12.6VAC CT	8amp	10.95
25.2VAC CT	2amp	7.95

PLUG CASE STYLE

12VAC	250ma	3.95
12VAC	500ma	4.95
12VAC	1amp	5.95
12VAC	2amp	6.95

DC ADAPATER

6, 9, 12 VDC selectable with universal adapter 8.95

NOTE: Please include sufficient amount for shipping on above items.

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CENTRONICS

IDCEN36	Ribbon Cable	36 Pin Male	6.95
IDCEN36/F	Ribbon Cable	36 Pin Female	6.95
CEN36	Solder Cup	36 Pin Male	7.95

DIP CONNECTORS

DESCRIPTION	HIGH RELIABILITY TOOLED ST IC SOCKETS	COMPONENT CARRIERS (DIP HEADERS)	RIBBON CABLE DIP PLUGS (IDC)
ORDER BY	AUGATxx-ST	ICCxx	IDPxx
CONTACTS 8	.99	.65	
14	.99	.75	1.45
16	.99	.85	1.65
18	1.69	1.00	
20	1.89	1.25	
22	1.89	1.25	
24	1.99	1.35	2.50
28	2.49	1.50	
40	2.99	2.10	4.15

For order instructions see "IDC Connectors" below.

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.

MOUNTING HARDWARE 1.00

IDC CONNECTORS

DESCRIPTION	SOLDER HEADER	RIGHT ANGLE SOLDER HEADER	WW HEADER	RIGHT ANGLE WW HEADER	RIBBON HEADER SOCKET	RIBBON HEADER	RIBBON EDGE CARD
ORDER BY	IDHxxS	IDHxxSR	IDHxxW	IDHxxWR	IDSxx	IDMxx	IDExx
CONTACTS 10	.82	.85	1.86	2.05	1.15	—	2.25
20	1.29	1.35	2.98	3.28	1.86	5.50	2.36
26	1.68	1.76	3.84	4.22	2.43	6.25	2.65
34	2.20	2.31	4.50	4.45	3.15	7.00	3.25
40	2.58	2.72	5.28	4.80	3.73	7.50	3.80
50	3.24	3.39	6.63	7.30	4.65	8.50	4.74

ORDERING INSTRUCTIONS: Insert the number of contacts in the position marked "**xx**" of the "order by" part number listed. **Example:** A 10 pin right angle solder style header would be IDH**10**SR.

Circle 206 on inquiry card.

FOR APPLE COMPUTER USERS

JDR Microdevices

THOUSANDS SOLD!

JDR 16K RAM CARD FOR APPLE II+

- ★ Expand your 48K Apple to 64K
- ★ Fully compatible with Apple Language System — Use in place of Apple Language card
- ★ Highest quality card features: gold edge connector, sockets for all IC's.
- ★ 2 YEAR WARRANTY

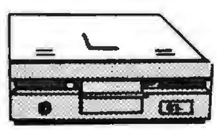
Kit with Instructions $40.95
Bare PC Card $14.95

$44.95

GET SLIM IN 1984!

JDR HALF-HEIGHT DISK DRIVE

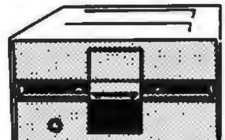
- ★ 35 Track if used with Apple Controller
- ★ 40 Track Controller and DOS Available (Call for Price)



$209.95

MA SYSTEMS

FD-35 DISK DRIVE



$199.95

- ★ Shugart Mechanism - Made in U.S.A.
- ★ Direct Replacement for Apple Disk II
- ★ Compatible with Apple Controller or other Apple compatible controllers
- ★ Specially designed electronics with **low power** consumption
- ★ DOS3.3and3.2 compatible
- ★ One Year Warranty

CONTROLLER CARD
$69.95

VISA   MasterCard

APPLE COMPATIBLE POWER SUPPLY

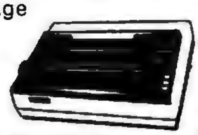
- ★ Use To Power Apple-Type Systems
- ★ +5V @ 5A +12V @ 3A
  -5V @ .5A -12V @ .5A
- ★ Instructions Included

$79.95

BMC BMX-80 PRINTER

- ★ 80 CPS Dot Matrix Printer
- ★ Prints Bi-Directional in 40, 80, 71 or 142 Columns in Normal, Double Width or Compressed Text.
- ★ Print Superscript As Well As Superb Graphics in Character or Bit Image

$279



micromax

VIEWMAX-80

***NOW ONLY* $159.95**

- ★ 80 Column Card for Apple II+
- ★ Video Soft Switch
- ★ Inverse Video
- ★ 2 Year Warranty

VIEWMAX-80e

***NEW* $129.95**

- ★ 80 Column Card for Apple IIe
- ★ 64K RAM Expandable to 128K

64K RAM Upgrade $47.60

GRAPHMAX $129.95

- ★ Hi Resolution Graphics
- ★ Printer Card
- ★ Centronics Parallel Interface

Graphmax with Color & Zoom Options ... $149.95

NASHUA DISKETTES

5¼" WITH HUB RING		
MD1	SOFT SECTOR, SS/SD	19.95
MD1D	SOFT SECTOR, SS/DD	26.25
MD2D	SOFT SECTOR, DS/DD	30.75
MD2F	SOFT SECTOR, DS/QUAD DENSITY	45.00
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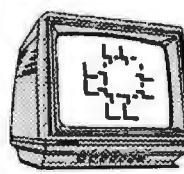

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Unclassified Ads

NEEDED: For care and training of mentally and physically disabled persons, nonprofit institute needs small computers, peripherals, printers, monitors, and programs (educational, games, administrative) for VIC-20, C-64, TRS 80, or whatever. All donations tax exempt; we pay shipping. Community Support Services Inc., 333 Lincoln St., Saco, ME 04072, (207) 282-6113 collect.

WANTED: Tax-deductible donations of computers, peripherals, and software for use by a public charity organization to teach computer skills to economically disadvantaged young people. San Pablo Institute, 234 Mullen St., San Francisco, CA 94110.

WANTED: Receive a tax deduction and help the Africa Fund's education and relief work by donating your Kaypro or other computer. Paul Irish, The Africa Fund, 198 Broadway, New York, NY 10038, (212) 962-1210.

WANTED: Tax-exempt, educational organization needs used computers or unused manufacturer's over-runs or obsolete models. K.C. Hill, Appalachian Educational Communication Corp., POB 2061, Bristol, TN 37621-2061, (703) 563-0371 ext 445 days and (615) 538-7877 evenings.

WANTED: Your fully tax-deductible donation of any computer (large, small, mini, personal), printers, disk drives, monitors in any condition for teaching programming and computers to incarcerated men. PGT, POB 574, Stanton, CA 90680.

WANTED: A computer science university student with experience in UNIVAC, CDC, BASIC, FORTRAN, and 6800 assembly seeks a two-month training course during summer 1984 in USA or Canada. Any advice welcome. Kilicaslan Mertan, Kasadar sok. 13-19, Bostanci, Istanbul, Turkey.

FREE: You pay small postage and I'll send you for free a box of left-over, mostly unused electronic components. Originally parts were to be used in an Electronotes Music Synthesizer system. It goes to the most convincing letter received within one month of this ad. Chuck Markham, 362 Commonwealth Ave. #2E, Boston, MA 02115.

WANTED: Maintenance manual or schematics for Beehive 12-inch terminal, PN 112-0014-3037, (manufactured about 1974), eight 7-by 10-inch plug-in boards). Dan Schacher, 20-08 Greenwood Dr., Fair Lawn, NJ 07410.

WANTED: College student would appreciate any unwanted computer equipment: boards, drives, etc. to be used for research. I will pay all shipping charges. Johnathan Jones, 1426 St. Marks Ave., Brooklyn, NY 11233, (212) 773-5983.

WANTED: TRS-80 users willing to exchange information or programs on designing a computer-controlled burglar-alarm system and control for lights, furnace, stove, sprinklers, and other noncomputer devices. I would also like information on voice recognition. I am using a Model III 48K but will convert to Model 4 128K. Patrick Baehl, 4652 126 Ave., Edmonton, Alberta T5A 4K9, Canada, (403) 476-7093.

WANTED: Atari 800 software to swap, especially utilities and entertainment. Send disk or tape with your programs and I will promptly send it back with mine. Matthew Meyerson, 8 Phyllis Circle, Garnerville, NY 10923.

FOR TRADE: Disk cartridge: seven Texas Instruments DS10 disk cartridges and one Control Data Corp. 847-51 CE disk cartridge, in perfect condition. Will consider donating to a worthwhile IRS-approved charity if unable to sell. Win Schaeffer, 3 Waters Edge Place, Lexington, KY 40502, (606) 268-0308 days.

WANTED: Junior high student seeks Apple II Plus DOS 3.3 for programming. Whole working parts or complete system. Will pay shipping and handling. Hans Hess, POB 4406, Carmel, CA 93921.

WANTED: HP-67 programmable calculator or HP-41C programmable calculator with a card reader. Indicate age, use, and/or condition. If you have additional peripherals or software, please include a list. Ken Hamel, Rt. 5 Box 162, Watertown, WI 53094.

FOR SALE: For the benefit the Mercer Island Area Computer Users Group (MIACUG): Eamon starter kit of 18 adventures (set 1) on 9 disks for $35. Set 2 of 18 more for $35, or all 36 for $60. Jeff Bianco, 7210 North Mercer Ways, Mercer Island, WA 98040.

FOR SALE: Hewlett-Packard HP85A, 32K RAM, Matrix ROM, BCD interface, additional hardware and software. Must sell. Stanley J. Cudnik, 712 Pennsylvania Ave., Trenton, NJ 08638, (609) 392-3725 evenings.

FOR TRADE: TS 1000/ZX-81 software. Send cassette of your best software (up to 64K) and I will promptly return an equal number of my best on your original tape. A. S. Cavaliere, 49 Grand View Blvd., Miller Place, NY 11764.

FOR SALE: Viewmax-80, 80-column video card for Apple II with 2-year warranty: $130. John Chen, 1602 Arlington, Caldwell, ID 83605.

FOR SALE: 8-bit AD/DAC IBM PC plug-in by Lab Tender #20028. Data-processing subsystem A/D 32 single-ended channels, 50KHz conversion rate, DAC 16 analog outputs, Digital 24 parallel I/O lines, Timer 5 independent, 16-bit timing counter 5MHz max, software is easy high level or assembly language; was $495, asking $385. John Vavrik, 2818A East Lake Sammamish N, Redmond, WA 98052, (206) 881-7414.

FOR TRADE: Send a list and/or disk of your better Apple software and I'll send mine. I'm interested in utilities, games, and educational programs. Prompt return guaranteed. George Velez, PSC Box 4146, APO NY 09109.

FOR SALE: Apple Silentype printer and interface card: $100 or best offer. Gene Stagner, 8420 East Appomattox, Tucson, AZ 85710, (602) 721-1251.

WANTED: Eagle II users interested in bumping heads on any subjects relating to the Eagle and/or forming a user group. G. David Yaros, 1006 2d Nat. Bldg., 830 Main St., Cincinnati, OH 45202.

FOR SALE: Two TRS-80 Model I disk drives to be used with a 16K Level II BASIC TRS-80 microcomputer. One is catalog #26-1160; other is #26-1161: $800 each. Anne Heitz, 2807 Ave. C, Ft. Madison, IA 52627, (319) 372-3058.

FOR SALE: Microsoft FORTRAN, 8-inch CP/M format, unused: $250. Strobe Plotter for Apple, unused: $350. Shadow Voice-Entry term for Apple: $400. Howard Rothman, 218 Huntington Rd., Bridgeport, CT 06608, (203) 579-0472 days, 333-6436 evenings.

FOR SALE: Timex/Sinclair 1000 with 16K RAM, tape recorder, and books. Also, Flight Simulator, Chess, Stock Option Analyzer, and Backgammon. All in excellent condition: $110 or best offer. David Patterson, 2151 West Rialto #12, San Bernardino, CA 92410, (714) 888-1050.

FOR SALE: Electronic Typewriter Interface (ETI2) for connection of IBM Electronic Model 50, 60, or 75 typewriter to parallel printer port of your computer. This unit has only one hour's usage. Cost $525, will sell for $400. K. C. Hartman, 200 Gateway Towers, Pittsburgh, PA 15222, (412) 281-1914.

FOR SALE: Printers: DECwriter II LA 36 with ASCII keyboard and adjustable paper width: $350. Desktop CDI 1030 with keyboard and built-in modem: $150. N. A. Westman, 11209 Hwy U, Wausau, WI 54401.

WANTED: Users of NEC PC-8001A series who are willing to exchange programs and/or information. George G. Bulick, 4228 Wilson Ave., Rolling Meadows, IL 60008.

FOR SALE: BYTE April 1977 to December 1977, 9 issues: $45. July 1978 to March 1980, 21 issues: $40. All plus postage. Mark Walbrun, 1326 Spruce St., Philadelphia, PA 19107.

FOR SALE: Netronics equipment, all in perfect condition. Smartterm 80-column terminal: $150. 64K Jaws S-100 RAM card: $100. HEX keypad: $25. All 1 year old. Bryan Bergeron, 1431 Josephine Apt. 7, New Orleans, LA 70130, (504) 524-1042.

FOR SALE: SS-50 assembled boards. Percom 6809 CPU: $50. Percom video board: $50. Datasystem-68 Disk Controller: $75. Tandon TM-100A disk drive with power supply and case: $100. RS-232C cassette interface: $25. Complete documentation with equipment. James A. Forsman, 136 Glenoak Rd., Wilmington, DE 19805, (302) 994-6312 after 5 p.m.

FOR SALE: Complete Commodore system includes 32K Commodore CBM 2001, 2040 dual disk (with write/protect switches), matrix printer, Word Pro II, Visicalc, Toolkit (programming aids), FORTH language with assembler, games, and numerous utilities. Full documentation: $4000 value, $1500 takes it. Steve Pothier, 8715 Datapoint Dr. #904, San Antonio, TX 78229, (512) 691-2890.

FOR SALE: APF black-and-white monitor, 9-inch screen, excellent condition: $49. Pick up preferred. Marvin Leifer, 185 West End Ave., New York, NY 10023, (212) 362-9097.

WANTED: Two Polish students/computer-enthusiasts seek donations of any computer equipment. Wojciech Siudek, 80-260 Gdańsk, ul. Leśny Stok 31, Poland.

WANTED: Apple's Lisa assembly-language programmers to test new library of assembly subroutines and library-maintenance program. These subroutines use a unique address structure that simplifies coding of large machine-language programs. Send name, address, system description, and brief statement of experience with Lisa Assembler. M. A. Iannce, 1009 Country Hills Rd., Santa Maria, CA 93455.

UNCLASSIFIED POLICY: Readers who have computer equipment to buy, sell, or trade or who are requesting or giving advice may send a notice to BYTE for inclusion in the Unclassified Ads section. To be considered for publication, an advertisement must be noncommercial (individuals or bona fide computer clubs only), typed double-spaced on plain white paper, contain 75 words or less, and include complete name and address. This service is free of charge; notices are printed once only as space permits. Your confirmation of placement is appearance in an issue of BYTE as we engage in no correspondence. Please allow at least three months for your ad to appear. Send your notices to Unclassified Ads, BYTE/McGraw-Hill, POB 372, Hancock, NH 03449.

WANTED: Hardware accessories for H/Z-89, with documentation. Interested in cassette interface, 64K RAM expansion, parallel interface, A/D converter, breadboards, soft-sector disk controller (5¼- or 8-inch), external disk drives (5¼- or 8-inch). Orville R. Weyrich Jr., POB 562, Auburn, AL 36831.

FOR SALE: Ohio Scientific C2-OEM 2MHz with two 8-inch disk drives, 48K static RAM, CA-10-2 (serial-interface board with printer and modem ports configured). Includes Word Processor, 6502 Assembler/Editor, and Extended Monitor: absolutely excellent condition. $3850 new, sell for $1200. Bob Duffett, POB 5548, Athens, GA 30604, (404) 353-3229 after 5 p.m.

FOR SALE: Inter-Tec Super Brain II, quad-density, dual drive, 750K, Z80 CPU 64K RAM, manuals, and CP/M operating system software, APL keyboard, and character-generating chip: $1695 or best offer. Bill Gibson, POB 428, Amherst, MA 01004, (413) 549-6334.

FOR SALE: SwTPC 6800 computer system MP-A, AC-30, MP-S, MP-C; MP-R EPROM programmer currently has 34K RAM and 4K EPROM expandable to 10K additional RAM or EPROMs. 4K EPROM monitor plus documentation. BASIC, Pascal, and lots of other programs. Best offer. T. Preston, 119 Hickory Lane, Medford, NJ 08055.

FOR SALE: ADDS CONSUL 980, excellent condition with 80 by 24 screen; serial, parallel, and RS232C (EIA) ports; switch selectable data rates; ½ full duplex; Mosaic high-resolution graphics; manuals included. Plus Anderson-Jacobson acoustic-coupler modem; EIA-RS232C 6-foot ribbon cable included. F. G. Volpicelli, 331 8th Ave., Pelham, NY 10803, (914) 738-1071.

FOR TRADE: OSI C-24P cassette-based with 4K RAM (expandable to 4K), 3-speed data rate, serial port, power supply, and two open slots on main board for Sharp 1500 with cassette interface. Needs capacitor replaced in the speed generator. Also, have expanded Gold Miner for TI 99/4A and will trade programs on tape. H. A. Etchason, Box 147, Sage, AR 72573.

FOR SALE: George Risk keyboard as used with Cromemco System; asking $75. M. D. Beck, 170 Hillside Ave., San Rafael, CA 94901.

FOR SALE: Radio Shack Line Printer VIII, 1 year old, excellent condition, cover included: $425. Also, R/S direct-connect modem II, 5 months old, excellent condition: $150. Model 3 RS-232 cable: $15. Videotex: $35. R/S Communications Package: $25 or will trade disks or tapes for TRS-80 Model III. Tom Trepanier, 35 Lincoln Ave., Ardsley, NY 10502.

FOR SALE: S-100 16K: $20. Double-density controller: $85. Z-80 CPU: $45. 5¼-inch 5M Winchester: $300. Z-80 big board: $150 assembled. Cherry PRO keyboard: $25. Send for complete list. Noor Singh Khalsa, 1562 North Hill, Pasadena, CA 91104.

FOR SALE: Texas Instruments Silent 700 (TI-745) and user's manual. Used less than six months, refurbished. Paul Berg, 31 Taunton Rd., Scarsdale, NY 10583, (914) 725-0261.

FOR SALE: HP98217A flexible disk ROM for 9825-plus 98034A HPIB(GPIB). Also, 98036A serial interface. Want HP 9845 mass storage ROM, HP9885M/S flexible disk drives. W. R. Flocks, 700 West Jackson #120, McAllen, TX 78501, (512) 682-6008.

WANTED: Information on any CP/M 2.2-compatible map-making programs for microcomputers similar to SYMAP program for mainframes. Bill Thomas, 532 University Ave., Missoula, MT 59801.

WANTED: I'd like to exchange programs and information for the Sirius-Victor personal computer. Maurizio Lazzaretti, Via Furini 14, 27058 Voghera (PV), Italy.

FOR SALE: SVA 8-inch drive controller with software for DOS and CP/M: $150. Qume DT8 8-inch drive just rebuilt by Qume: $200. Bill Kimball, 244 North Orange Grove, Pasadena, CA 91103.

FOR SALE: Heath H-8 computer includes mainframe, terminal, and double-disk drives. Bus-oriented system enables expansion in almost any direction, including (but not limited to) color graphics, hard disk, multiuser, etc. Software and a complete manual set are included: cost $2500, $1150 or best offer. Jon Swindle, 1506 East 1650 N, Provo, UT 84604, (801) 377-1506.

FOR TRADE: ZX-81, much software, 17-inch black-and-white monitor; for any TI-99/4A items. Would like to exchange TI information with users. Bill Axsom, 661 Northwest 75th Terrace, Plantation, FL 33317.

FOR SALE: High-resolution color monitor, Zenith ZVM-134 with RGB inputs, 640 by 225 pixels, 80 characters by 25 lines. Used only 3 months, was $699, asking $390, including postage within continental U.S. Len Whitten, 7613 Jadeite Ave., Cucamonga, CA 91730, (714) 382-5405 days, 980-2509 evenings.

FOR SALE: BYTE, July 1976 and October 1976 to present (missing May 1978). Interface Age, January 1977 to present. Dr. Dobbs Journal, March 1976 to August 1982. Kilobaud Microcomputing, January 1977 to present. Lifelines, June 1980 to present. Sell complete sets only; each set sold to highest bidder; you pay postage. Dr. J. Williams, 902 Anderson Dr., Fredericksburg, VA 22405.

FOR SALE: Victor 9000 16-bit microcomputer with 256K expandable to 896K has 2.4 mg disk storage on two double-sided, 5¼-inch floppy-disk drives. Also Codec digitized voice, green phosphor high-resolution (800 by 400) graphic display; CP/M-86, MS-DOS, and BASIC86 included. More software available. List $4795, asking $3800. Used MX-100 dot-matrix 80-cps printer: $400. Diablo 1641 send/receive daisy-wheel printer, cost $3300, asking $2000. Robert De Boer, 3354 Louise Dr., Lansing, IL 60438, (312) 474-2634.

Unclassified Ads

FOR SALE: Single supply 2716 EPROMs: $3. 8279 keyboard and display interface: $7. Quantities limited, send check or money order. James Major, 1002 South 45 St., Omaha, NE 68106, (402) 551-3240.

FOR TRADE: Apple II Plus and IIe programs ranging from business to games. Let's trade programs; I'll even pay for disk and shipping costs. Mike Klemens, 3208 Los Prados, San Mateo, CA 94403, (415) 341-1747.

WANTED: Information exchange with persons building the Ciarcia MPX-16 computer. I also am interested in trading programs for the PC that will run on the MPX-16. Send your list and I'll send mine. S. A. Glick, 404 Griffin St., West Point, MS 39773.

FOR SALE: HP-85A microcomputer with 32K RAM, built-in tape drive, printer, monitor, all in very good condition; excellent as a controller. Also, HP-IB interface, various ROMs, and Visicalc. Will sell complete, or in parts. Everything comes with original documentation. Cornelia Soderquist, Box 1176, Sun Valley, ID 83353, (208) 726-3816 evenings.

FOR SALE: TRS-80 software: Accounts Payable, Accounts Receivable, Order Entry/ICS, General Ledger: $375 each or best offer. Compiler BASIC: $150. May be purchased separately or as package. B. Lawrence, 2049 Brown Ave. Apt. #C-19, Bensalem, PA 19020, (215) 639-1318.

FOR TRADE: I would like to exchange IBM PC software: different languages, business, games. Send a list. Winfred Schleusner, 19600 Gulf Blvd., Indian Shores, FL 33535, (813) 595-8078.

FOR SALE: OSI C4P-MF, 28K plus two 4K boards (not yet installed), disk drive, RS-232C interface, printer port, modem port, two joystick ports, sound, color; software documentation, and article collection. Novation modem, extra: $650, negotiable. Ted Morris, 6306 Kincaid Rd., Cincinnati, OH 45213, (513) 731-3451 evenings.

WANTED: West Australian NEC PC8001 owner would like to communicate with any interested users or user groups. Very little information or software available here, need any technical information, particularly memory expansion. Will exchange local information, Australiana. Michael Brown, 5 Baring St., Mosman Park 6012, West Australia.

WANTED: BYTE back issues: vol. 1: #1 to #10, #12 to #16. Vol. 2: #1, #2, and #4. Vol. 3: #1 and #11. Will pay $4 each. Terry J. Deveau, Site 17, Box40, RR#5, Armdale, Nova Scotia B3L 4J5, Canada.

FOR SALE: 151 Century computer, 256K memory, 6 disk drives, 36 disks, 1200 line-per-minute printer. MMI Preparatory School, POB 89, Freeland, PA 18224-0089, (717) 636-1108.

FOR SALE: Personal Computing, January 1977 (first issue) through July 1981, complete: $15 plus UPS. Gordon E. Nelson, 12005 Millstream Dr., Bowie, MD 20715, (301) 464-0732.

FOR TRADE: My cross assembler for Apple II using cassette interface for interesting applications programs for Hero-1 robot. Dave Fentress, Pergolastr. 6, CH-3184 Wunnewil, Switzerland; tel: 1141/37/361720.

FOR SALE: Unused S-100 bus with 64K: $250. Cromemco Z-2D with extras, software, and documentation: best offer. Centronics printer 101-A: freight collect (75 lbs.) and best offer. Three memory boards 16K, OSI C2-4P: best offer. (For an OSI C1P with 32K and more, call Pete.) Walt Thomas, RD#1, Box 135, Linden, PA 17744, (717) 398-1893.

WANTED: Student enthusiastic about computer information needs donation of any personal computer. T. Jarosinski, 41/16 Michaelowskiego, 80-300 Gdansk, Poland.

WANTED: Any technical information regarding the Victor 9000 computer. Specifically, I would like instructions for the use of graphics and the CODEC voice digitizer through MSBASIC or CBASIC. Also, I would like to form a users's group for the Victor 9000 computer and any subsequent Victor models. Mike Frey, 20048 Shoshonee, Apple Valley, CA 92307.

FOR SALE: Back issues of BYTE, Microcomputing, Interface Age, Dr. Dobb's, 68 MicroJournal, and Computer. Make an offer. Phil Hughes, POB 7, Northgate Station, Seattle, WA 98125, (206) 367-8649.

FOR SALE: Quick printer uses 5-inch aluminum paper for quick output (2.5 lines per second). No ribbon needed; parallel interfacing; prints up to 80 characters per line; prints true descending lowercase and underlines; good working condition; two extra rolls of paper. First check received for $75 that clears takes it or offers. Tom P. Douglas, POB 9046, Colorado Springs, CO 80932, (303) 635-2061 Sundays.

BOMB

BYTE's Ongoing Monitor Box

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JANUARY'S WINNING WORDS

First place in January's BYTE goes to Steve Ciarcia's "Build the Circuit Cellar Term-Mite ST Smart Terminal, Part 1: Hardware." Steve wins the $100 bonus. Richard Mateosian, author of "1984, the Year of the 32-bit Microprocessor," wins $50 for capturing second place. In a close third ce is Jerry Pournelle's User's Column, "Too Many Leads, or What in *;?!#"*? Goes First?" "Computer-aided Design," written by Rik Jadrnicek is the fourth winner. In fifth place is Louis Wheeler's "Bubbles on the S-100 Bus, Part 1: The Hardware." Congratulations to these authors.

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