BYTE®

the small systems journal

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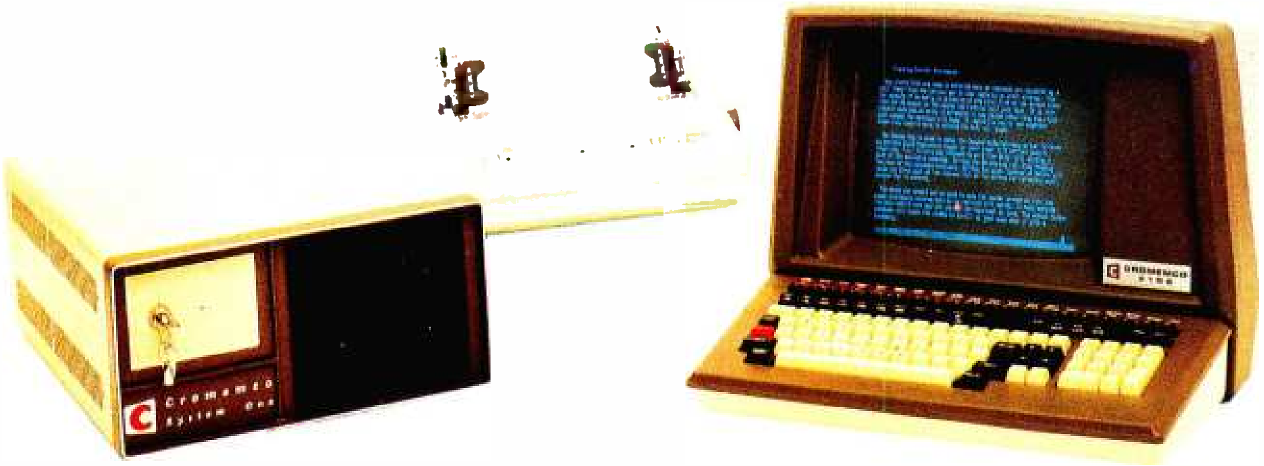
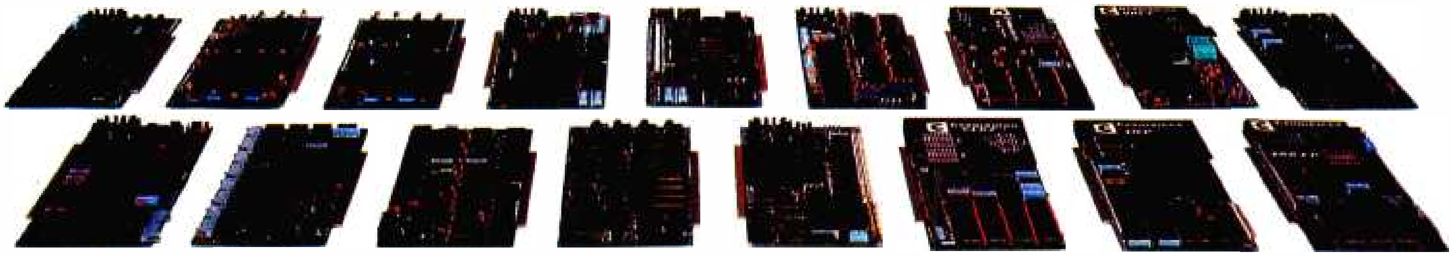
Interactive Videodiscs

A new small computer that won't limit you tomorrow



New Cromemco System One shown with our high-capability terminal and printer.



Expandability

Here's a low-priced computer that won't run out of memory capacity or expandability halfway through your project.

Typically, computer usage tends to grow, requiring more capability, more memory, more storage. Without a lot of capability and expandability, your computer can be obsolete from the start.

The new System One is a real building-block machine. It has capability and expandability by the carload.

Look at these features:

- **Z80-A processor**
- **64K of RAM**
- **780K of disk storage**
- **CRT and printer interfaces**
- **Eight S-100 card slots, allowing expansion with**
  - **— color graphics**
  - **— additional memory**
  - **— additional interfaces for telecommunications, data acquisition, etc.**
- **Small size**

GENEROUS DISK STORAGE

The 780K of disk storage in the System One Model CS-1 is much greater than what is typically available in small computers. But here, too, you have a choice since a second version, Model CS-1H, has a 5" Winchester drive that gives you **5 megabytes** of disk storage.

MULTI-USER, MULTI-TASKING CAPABILITY

Believe it or not, this new computer even offers multi-user capability when used with our advanced CROMIX* operating system option. Not only does this outstanding O/S support multiple users on this computer but does so with powerful features like multiple directories, file protection and record level lock. CROMIX lets you run multiple jobs as well.

In addition to our highly-acclaimed CROMIX, there is our CDOS*. This is an enhanced CP/M† type system designed for single-user applications. CP/M and a wealth of CP/M-compatible software are also available for the new System One through third-party vendors.

COLOR GRAPHICS/WORD PROCESSING

This small computer even gives you the option of outstanding high-resolution color graphics with our Model SDI interface and two-port RAM cards.

Then there's our tremendously wide range of Cromemco software including packages for word processing, business, and much more, all usable with the new System One.

ANTI-OBSOLESCENCE/LOW-PRICED

As you can see, the new One offers you a lot of performance. It's obviously designed with anti-obsolescence in mind.

What's more, it's priced at only $3,995. That's considerably less than many machines with much less capability. And it's not that much more than many machines that have little or nothing in the way of expandability.

Physically, the One is small — 7" high. And it's all-metal in construction. It's only 14⅛" wide, ideal for desk top use. A rack mount option is also available.

CONTACT YOUR REP NOW

Get all the details on this important building-block computer. Get in touch with your Cromemco rep now. He'll show you how the new System One can grow with your task.

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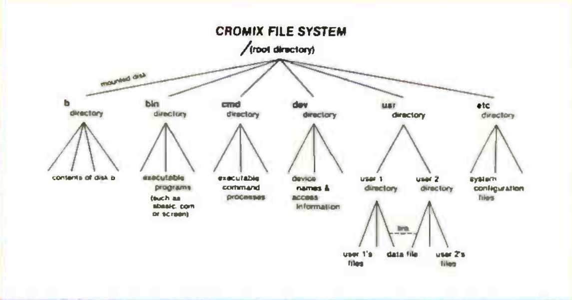

CROMIX*— Cromemco's outstanding UNIX†–like operating system

CROMIX is just the kind of major development you've come to expect from Cromemco. After all, we're already well-known for the most respected software in the microcomputer field.

And now we've come up with the industry's first UNIX-lookalike for microcomputers. It's a tried and proven operating system. It's available on both 5″ and 8″ diskettes for Cromemco systems with 128K or more of memory.

Here are just some of the features you get in this powerful Cromemco system:

- Multi-user and multi-tasking capability
- Hierarchical directories
- Completely compatible file, device, and interprocess I/O
- Extensive subsystem support

FILE SYSTEM

One of the important features of our CROMIX is its file system comprised of hierarchical directories. It's a tree structure of three types of files: data files, directories, and device files. File, device, and interprocess I/O are compatible among these file types (input and output may be redirected interchangeably from and to any source or destination).

The tree structure allows different directories to be maintained for different users or functions with no chance of conflict.

PROTECTED FILES

Because of the hierarchical structure of the file system, CROMIX maintains separate ownership of every file and directory. All files can thus be protected from access by other users of the system. In fact, each file is protected by **four separate access privileges** in each of the three user categories.

TREMENDOUS ADDRESS SPACE, FAST ACCESS

The flexible file system and generalized disk structure of CROMIX give a disk address space in excess of one gigabyte per volume — file size is limited only by available disk capacity.

Speed of access to disk files has also been optimized. Average access speeds far surpass any yet implemented on microcomputers.

'C' COMPILER AVAILABLE, TOO

Cromemco offers a wide range of languages that operate under CROMIX. These include a high-level command process language and extensive subsystem support such as COBOL, FORTRAN IV, RATFOR, LISP, and 32K and 16K BASICs.

There is even our highly-acclaimed 'C' compiler which allows a programmer fingertip access to CROMIX system calls.

THE STANDARD O-S FOR THE FUTURE

The power and breadth of its features make CROMIX the standard for the next generation of microcomputer operating systems.

And yet it is available for a surprisingly low $595.

The thing to do is to get all this capability working for you now. Get in touch with your Cromemco rep today.

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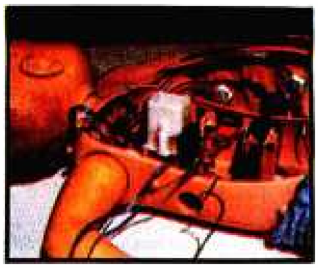

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In This Issue

Imagine carrying around the entire Encyclopaedia Britannica in your shirt pocket with room left over for every issue ever published of The New York Times and then some. Videodiscs and optical data storage technology have the potential to make this a reality. They also promise to provide a medium for an effective delivery of information hitherto impossible. Several articles this month illustrate the possibilities. Dick Moberg and Ira M. Laefsky describe one use for videodiscs in "Videodiscs and Optical Data Storage." Rod Daynes presents a primer on the video aspects of videodisc production in "The Videodisc Interfacing Primer." In "Videodiscs in Education" Isaac I. Bejar discusses ways in which videodisc technology might affect teaching methods. David Hon describes teaching lifesaving techniques with the aid of videodiscs and computers in "Interactive Training in Cardiopulmonary Resuscitation." And Steve Ciarcia's project is how to "Build an Interactive-Videodisc Controller." Thomas E. Kurtz, co-author of the original Dartmouth BASIC, surveys what's in the proposed ANSI standard and why it's there. Roger Taylor and Phil Lemmons explain what's really involved in adapting 8-bit software to a 16-bit environment in "Upward Migration, Part 1: Translators." Steve Leibson's "The Input/Output Primer" continues with "Part 5: Character Codes." Of course, we have Jerry Pournelle, William Barden Jr., and all our other regular features.

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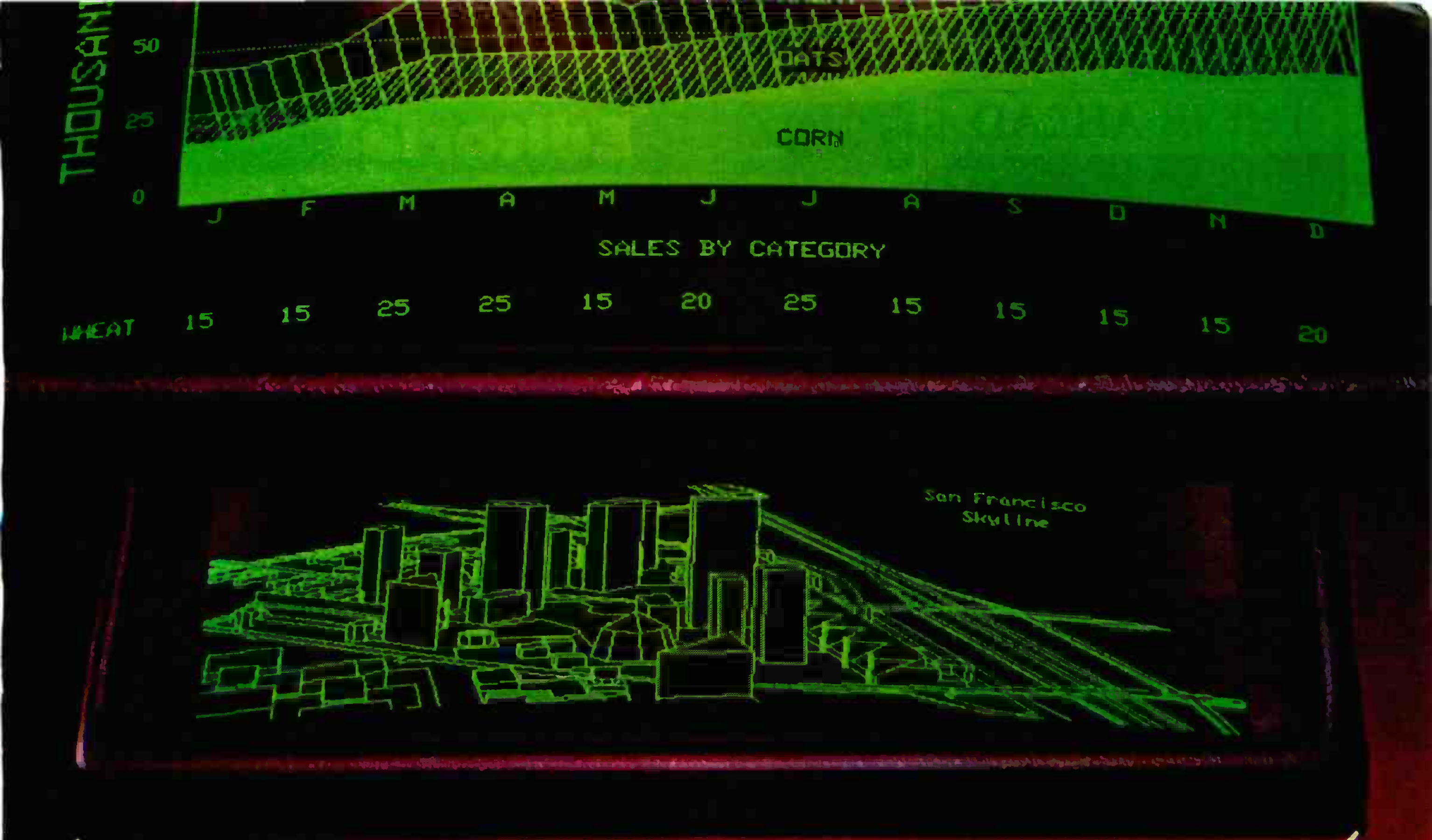

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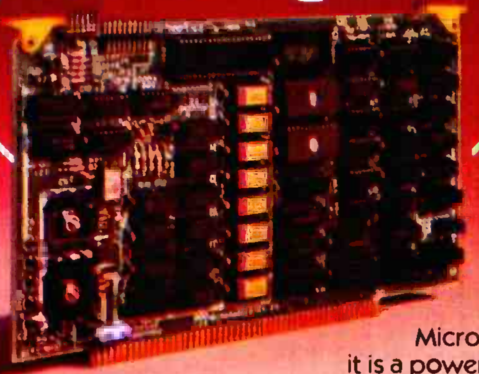

The OEM's best choice for graphics is MicroAngelo,™ the single board graphics display computer from SCION. Install MicroAngelo in your Multibus or S-100 host and let this intelligent display processor bring your screen to life with full graphics and text. MicroAngelo features 512 by 480 pixel graphics and 40 line by 85 character text displays.

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Editorial

West Coast Computer Faire Report

by Chris Morgan, Editor in Chief

You are in a large, cavernous building. To the north, south, east, and west are booths—all filled with microcomputer hardware and software. You are equipped with (1) a BYTE plastic bag, (2) a press badge, (3) a camera, and (4) sensible shoes. Your goal: see everything in the building in three days.

A stream flows into the building from the north—a stream of 40,000 people that is, who poured into the Seventh West Coast Computer Faire held in San Francisco this past March. It was the ultimate adventure game for personal computer lovers.

By some accounts it was a relatively tame show. Indeed, many of the expected blockbuster announcements were held in reserve for the National Computer Conference (underway in Houston as this issue appears). Nonetheless, for patient show-goers there were enough rewards to make the show a real success. I'll touch on a few highlights here.

A Beautiful Concept

Ironically, the most interesting product I saw during my trip to the West Coast was not on public display. It's the Corvus Concept computer, manufactured by Corvus Systems (2029 O'Toole Ave., San Jose, CA 95131). I made a special trip to San Jose immediately after the Faire to see this new state-of-the-art personal computer.

In looks alone, the Concept is a hands-down winner. But more important, it offers an amazing number of features for its $4995 suggested retail price tag. It has a 68000 16-bit processor; 256K bytes of RAM standard (512K bytes optional); a 120-column by 66-line (!) bit-mapped black-and-white display

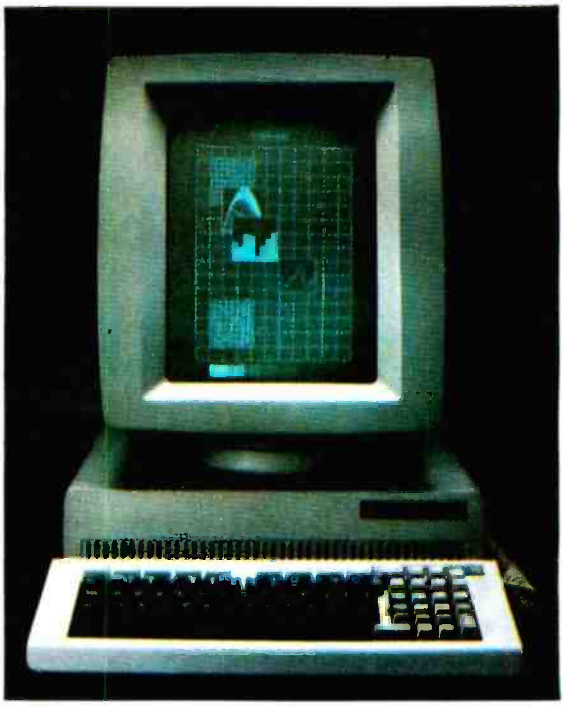

Photo 1: *The Corvus Concept computer, which features a 68000 processor and a 120-column by 66-line display. Suggested retail price is $4995.*

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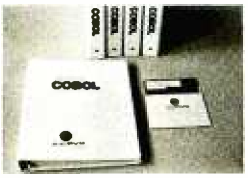

(560 by 720 pixels, versus 808 by 1024 for the Xerox Star—you can get the equivalent of eight Apple II images on the Corvus screen, albeit without color); mixed text and graphics on the same page; on-screen window management; ISO Pascal as the main language; Selectric-style keyboard with 10 programmable-function keys (key labels appear along the bottom of the display, à la Hewlett-Packard); built-in Omninet local network hardware; and various software packages, including a CP/M emulator in software that runs regular CP/M programs (although somewhat more slowly than most standard CP/M machines); Logicalc (a Visicalc look-alike spreadsheet program), and Edword, a sophisticated word processor. The Concept's operating system (designed by Corvus) is menu-based, which makes the machine a natural for Unix. In fact, it would be an excellent candidate for a Smalltalk system. Its designers say they are working on an experimental "mouse" (a small, mechanical interface that lets the user position the cursor on the screen by rolling the interface box on a flat surface and select screen menu options by pressing buttons). Such a unit is currently available on the Xerox Star system.

Good Design

The Concept is one of the best-designed computers I've seen in the microcomputer field, and it will set the price/performance standard in its price class for some time to come. The only machine that may give it real competition is the still-under-wraps Apple Lisa machine. Details about Lisa and its date of introduction are still sketchy. It's rumored to have graphics comparable to the Concept, but it may end up costing more.

The Concept resembles the Xerox Star in many ways. The user-definable screen windows bear an uncanny, though perhaps not entirely accidental, resemblance to those on the Star. And while it lacks some of the flexibility and sophistication of the Star's estimable software package, it comes surprisingly close in its hardware features—screen resolution, for instance. It's a pleasure finally to be able to see an 8½ by 11 page of text displayed on a personal computer screen as it will appear on paper when printed. And all this for about one-third the price of the Star!

Flipping Your Display

Another novel feature of the Concept is the switchable display screen (made by Ball Brothers). It's but the work of a few seconds to remove the screen from its quick-release flange mount (the screen can be tilted and swiveled by the operator for optimum viewing angle) and flipped 90 degrees to get a horizontal aspect ratio. A quick press of a key converts the characters on the video screen to either horizontal or vertical display. Having the two options is a real convenience: the horizontal mode is perfect for spread-sheet programs and the vertical mode lends itself well to word processing.

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The Edword word processor (designed by Corvus) has one feature that's worth the price of admission: an Undo key that lets you "undo" what you've done to your text file *all the way back to the beginning of the editing session*. Some other word processors have limited "undo" capability, but this is the first I've seen in which the program gives you so much power. An optional Corvus hard disk attached to the Concept contains the Mirror backup system that works in conjunction with any standard VHS video-tape recorder with remote control. The system can be programmed to come on at any time (nighttime is probably most convenient) and back up and verify the contents of the hard disk. The procedure takes about 15 minutes. And you can program the computer to automatically save the contents of your current working file to disk as often as every 10 seconds.

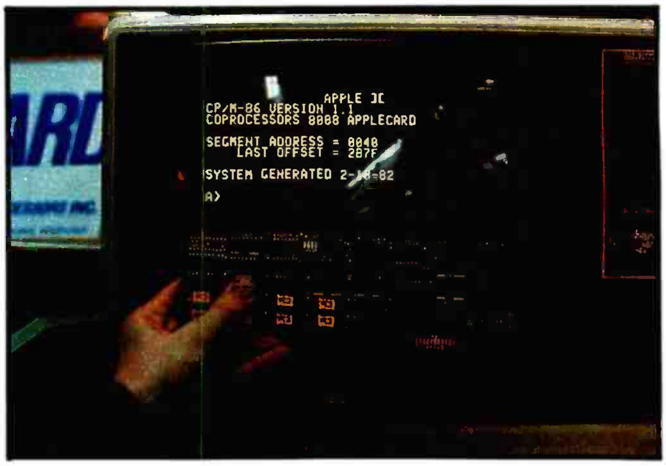
A drawer in the back of the Concept opens to reveal a motherboard that, the company says, will accept some (not all) of the available Apple peripheral boards on the market. That's another unexpected feature that makes this computer so intriguing.

The Corvus designers have paid a lot of attention to minor and major details that other companies have passed over. The result is a major advance in the current state of the art in personal computer design.

In today's age of giant computer makers, it's ironic—and reassuring—that some of the best designs can still come from the most unexpected sources.

New Products at the Faire

I saw several plug-in boards designed to let you run software written for one computer on another computer. One such board is the Baby Blue from Xedex Corporation (645 Madison Ave., New York, NY 10022). This $600 board lets IBM Personal Computer users run standard CP/M programs. With the board in place, a program with a Baby Blue header loads under PC DOS into native memory and is executed. The header instructs the IBM's



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            APPLE ][
CP/M-86 VERSION 1.1
COPROCESSORS 8088 APPLECARD

SEGMENT ADDRESS = 0040
    LAST OFFSET = 287F

SYSTEM GENERATED 2-18-82

A>
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Photo 2: *Coprocessors' 8088 conversion card for the Apple II.*

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Versatility and compatibility are two important features of PIEWriter. While some word processors for the Apple II computer will only work with specific accessories, such as 80-column display boards, lowercase adaptors and printers, PIEWriter is versatile enough to work with almost any combination of these. If you have any one of these hardware accessories in your system, Hayden has a PIEWriter for your particular configuration.

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Photo 3: *Full-View 80, an 80-column conversion board for the Atari 800, from Bit 3 Computer Corporation.*

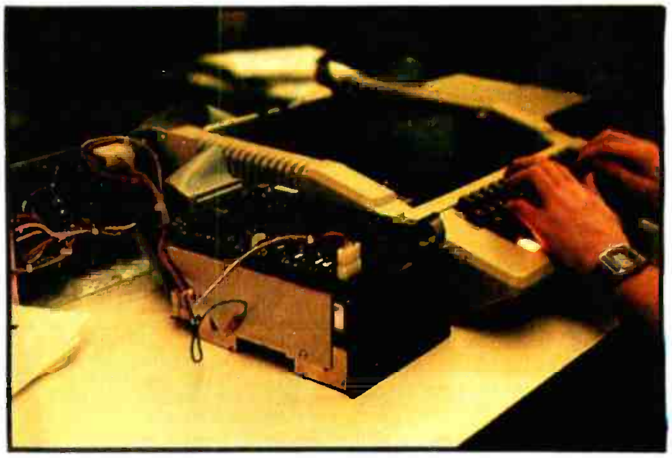

Photo 4: *The Xebec 5-megabyte hard disk and controller kit for $1295.*

8088 processor to run the program on the Baby Blue's built-in Z80B processor.

From Coprocessors Inc. (50 West Brokaw Rd., Suite 64, San Jose, CA 95110) comes the 88-Card, a plug-in card that effectively converts the Apple II to 16-bit operation, complete with PC DOS (see photo 2). The board also adds 64K bytes of memory to the Apple, all for $899. Another such board is the Apple '88 Up-Grade Board from Systems Research (4355 West Tropicana, Las Vegas, NV 89103). It has CP/M-86 and an 8088 processor but no memory; it retails for $550. The Apple probably now holds the all-time championship for being able to emulate the highest number of different computer systems via plug-in boards.

At last someone has come up with a badly needed board: a plug-in card that converts the Atari 800 to 80-column operation (see photo 3). It's called Full-View 80, and it's available for $379 from Bit 3 Computer Corporation (8120 Penn Ave. S, Suite 548, Minneapolis, MN 55431).

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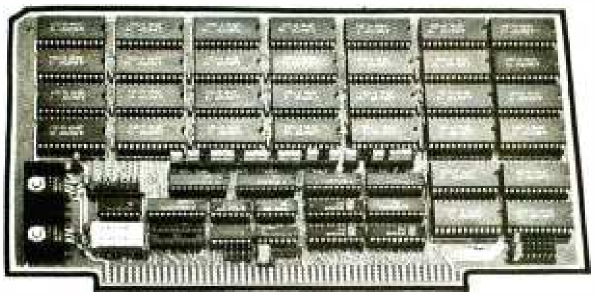

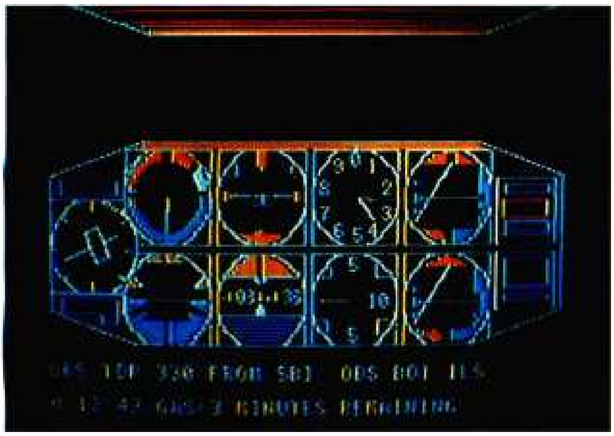

Photo 5: *Non-Linear Systems' Kaycomp II computer.*

A Best Buy

Looking for a great buy? The Xebec 5-megabyte hard disk and controller is hard to beat at $1295 (see photo 4). But there's a catch: it's a kit. The manufacturer (Xebec, 432 Lakeside Dr., Sunnyvale, CA 94086) claims that assembly takes only 10 minutes or so because the various subassemblies, including the controller board, come preassembled. If the kit, which comes with either Apple DOS or CP/M software, is as easy to assemble as Xebec says (we haven't had time to evaluate it yet), it could be the bargain of the year.

Osborne Look-Alike

Non-Linear Systems Inc. (533 Steven Ave., Solana Beach, CA 92075) introduced the Kaycomp II (see photo 5), a portable Osborne 1 look-alike that sells for the same price as the Osborne ($1795) and sports features such as a Z80 processor, two built-in 5¼-inch floppy-disk drives, CP/M, MBASIC, Multiplan (similar to Visicalc), and a word processor (the negotiations for which were still underway at the time of this writing). The Kaycomp II's screen is bigger than the Osborne's, measuring 9 inches diagonally, and it displays a full 80 columns per line. In addition, some people feel the Kaycomp II's keyboard has a better layout and key response. It's an interesting entry from a company that has been in the electronics field since the early fifties. NLS was the originator of the digital voltmeter back in the days of Nixie tubes. Whether NLS can beat Osborne's significant headstart in marketing remains to be seen.

The 68000 Pulls Ahead

The 68000 seems to be the leading 16-bit processor at the moment in terms of the number of new computers that use it. New 68000-based machines were on display from Sage and Fortune, as well as the previously mentioned Corvus Concept Computer. Add the TRS-80 Model 16 to that list and you can see that the 68000 has made fast inroads into the market. Look for more 68000-based machines in the near future, including en-

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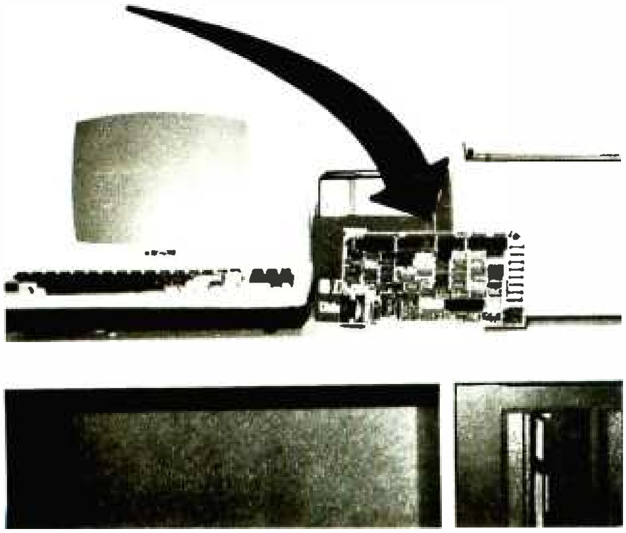

tries from Epson and Apple (in the case of the latter, probably later this year).

More Developments

The FORTH Interest Group and the Japan Microcomputer Club were two of the more interesting nonprofit groups displaying wares at the show. FORTH in particular seems to be thriving among computer devotees looking for an original (to say the least!) approach to language design.

Scott Kim entranced visitors at his booth by creating "inversions" of their names. Inversions are words that read the same right-side-up and upside-down or that exhibit other interesting symmetry features. (I highly recommend Scott's book, *Inversions*, published by BYTE Books. It is an example of brilliant visual pyrotechnics.)

Volkswriter promises to be one of the best IBM-based word processors yet, and the $195 price is right too (see photo 6). It is a stand-alone program written in Microsoft Pascal (which compiles to 8088 machine language), so it is fast. Volkswriter is also highly integrated into the IBM Personal Computer; for example, it makes use of more than 64K bytes of memory and uses the IBM function keys. Volkswriter is available from Lifetree Software Inc. (177 Webster St., Suite 342, Monterey, CA 93940).

Seven West Coast Faires Already?

It's hard to believe this was the *seventh* WCCF. It seems like only yesterday I attended the first one. Over the years the show has gone from a gathering of aficionados and slightly eccentric computer hackers to a major show attracting a wide range of people. I saw a lot more three-piece suits this year than in years past, but I still saw a comforting number of (now slightly aging) left-wing computer activists haunting the show. The microcomputer field manages to remain both egalitarian and vital at the same time. Quite a trick.

Photo 6: *Volkswriter, an inexpensive word processor for the IBM Personal Computer.*

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Photo 7: *DEC's new Professional 350 personal computer.*

New Computers from DEC

Digital Equipment Corporation (DEC) has introduced three new personal computers. They are being displayed at this month's National Computer Conference. The low-end model, called the Rainbow 100, is designed to compete with the IBM Personal Computer. Similar to the IBM in many ways, it features a dual processor board with Z80 and 8088 processors; CP/M8086 (part of the new Softsense package that automatically picks the right processor to run either CP/M or CP/M-86 programs); MS-DOS operating system compatibility; two dual 5¼-inch floppy-disk drives with a total of 1.6 megabytes; a 12-inch display with 80 columns by 24 lines or 132 columns by 24 lines of characters; up to 256K bytes of RAM; a graphics/color option; and an optional color monitor. Prices for the Rainbow 100 start at approximately $3000.

The second model, the DECmate II, is word-processing and business oriented. It features a 6120 processor (which uses the PDP-8 instruction set). Prices start at $4000. The third model comes in two configurations: the Professional 325 and the Professional 350. Both feature DEC's F-11 processor and VAX-compatible files. The 350 also allows the user to add an optional 5-inch hard-disk drive. The Professional series starts at $5000. A sophisticated combination telephone-management/voice-actuation system will be announced later this year. At a recent preview showing, we were impressed by the modular construction of the computers (modules snap out for easy replacement by users), the excellent color graphics, and the well-designed keyboards.

News from Cromemco

Cromemco is introducing a new personal computer at the NCC. We've learned that it is a 64K-byte, Z80-based

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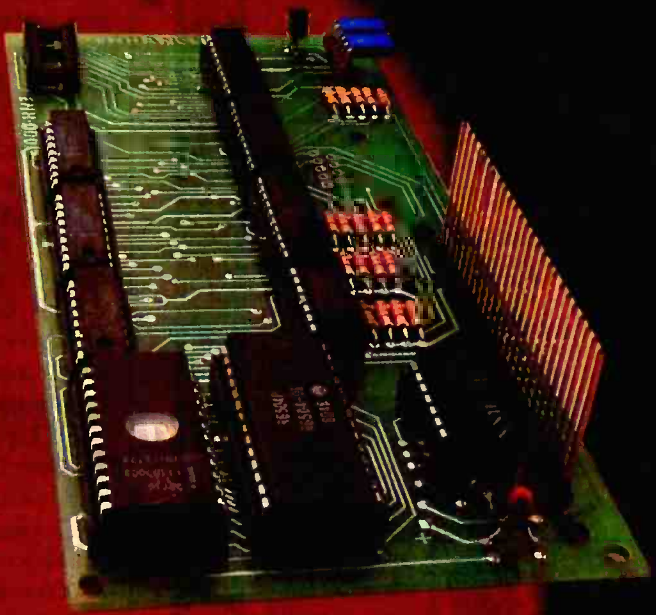
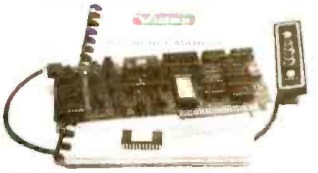
THE DAWN OF A NEW ERA FOR APPLE][®: THE ENHANCER][

Introducing the Enhancer][: a new Standard which is improving the relationship between Humans and Apples. The Enhancer][can help your Apple]['s keyboard become more sociable by remembering words or phrases which can be entered into the Apple by the mere touch of a key. Life can become even easier because the Enhancer][can remember what you typed while your Apple was busy talking to your disc (or doing other things). Naturally, it knows the difference between upper and lower case letters and what shift keys are supposed to do. It even knows to auto repeat any key held down. The Enhancer][replaces the encoder board making installation simple.

Suggested retail price: $149.00.



VIDEOTERM



The time tested Videoterm 80 column card:

- 80 characters × 24 lines
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- 7 × 9 character resolution
- Low power consumption
- Compatible with most word processors
- Softcard and CP/M compatible
- Modem compatible
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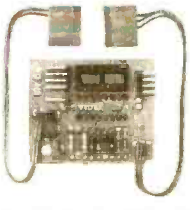
- Alternate character fonts available

Suggested retail price $345.00

SOFT VIDEO SWITCH



The Soft Video Switch is an automatic version of the popular Switchplate. It knows whether it should display 40 or 80 columns or Apple graphics. It does the tedious work of switching video-out signals so you don't have to. The Soft Video Switch can be controlled by software. Any Videoterm with Firmware 2.0 or greater may be used with the Soft Video Switch. The single wire shift mod is also supported. Package price is $35.00.

KEYBOARD AND DISPLAY ENHANCER

The original Keyboard and Display Enhancer is still available for Revision 0-6 Apples (on which the new Enhancer][will not fit). These Apples have memory select sockets at chip locations D1, E1 & F1. The Keyboard and Display Enhancer allows entry and display of upper & lower case letters with fully functional shift keys. It does NOT have user definable keys nor a type ahead buffer. The price is $129.00.

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• Pascal Mid-Res Graphics	
• Applesoft Read Screen Utility	
• Top & Bottom Scrolling	
• Pascal Vidpatch	
• Graphics Template	
Character Set EPROMs	$29.00 ea
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• Inverse	
• German	
• Katakana (Japanese)	
• Line Drawing Graphics (Expanded)	
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• French	
• Math & Greek Symbols	
• Super & Subscript	
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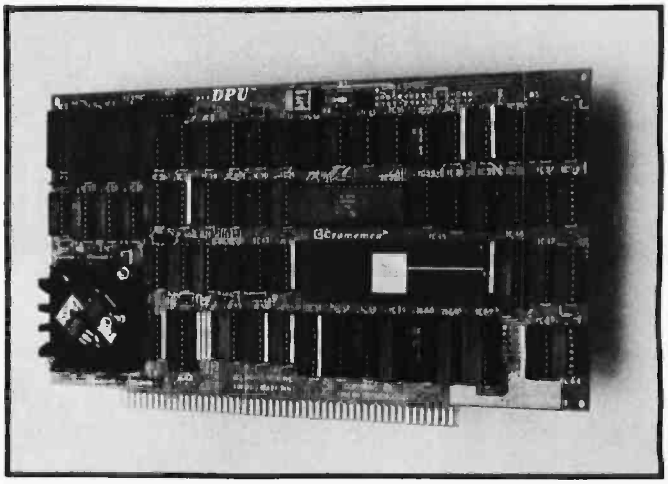


Photo 8: *Cromemco's dual-processor unit combines a 68000 processor with a Z80A for easy expandability of existing microcomputer systems.*

machine with a number of custom LSI (large-scale integration) chips. The custom circuits implement the built-in network interface and display. The computer has a detachable keyboard (individual keys may be redefinable) and a 25-line by 80-column green-phosphor display. It's priced under $2000.

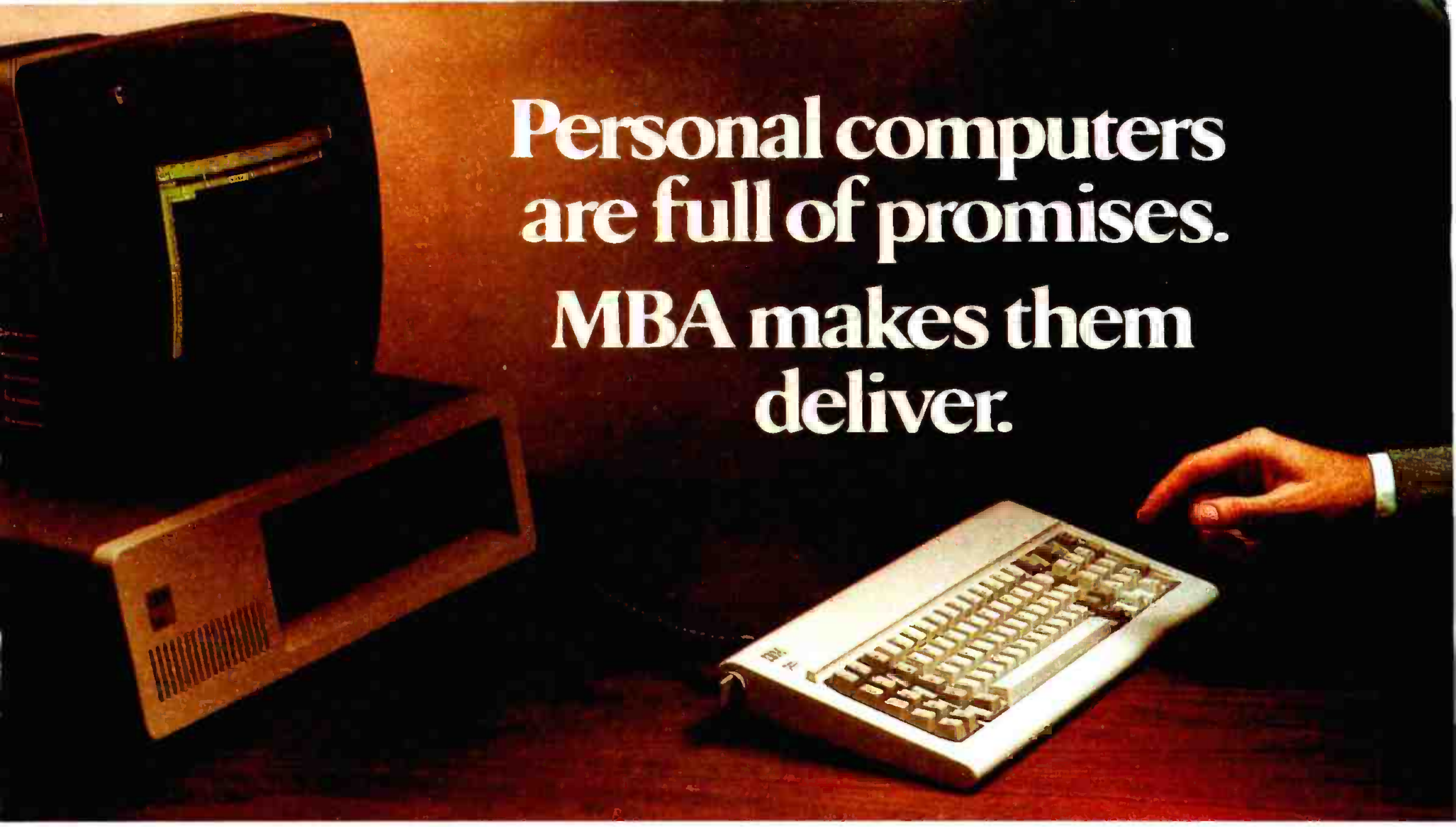
The network interface allows the computer to be used as a work station on Cromemco's recently announced C-NET, an Ethernet-like system employing an industrial-quality, shielded, twisted wire pair. It is broadband in nature, capable of carrying voice and video too. Cables are driven through isolation transformers by a differential transmitter/receiver, thus providing excellent noise immunity and immunity to single station failures. The C-NET protocol has full collision detection and CRC error detection, and data is transmitted at 880K bits per second. Stations may be as far apart as 2000 meters.

Cromemco is also showing its new 68000/Z80 DPU (dual-processor unit) at the NCC (see photo 8). The 68000 was chosen primarily because of its 32-bit architecture and its large (16-megabyte) addressing range. The two processors may be used in tandem, and the Z80 provides compatibility with existing software.

* * *

"Dum Volvo, Video Disco"

Our theme this month is videodiscs. And few words sum up better the benefits of a videodisc coupled with a microcomputer than the Latin phrase *dum volvo, video disco*. It means "while I turn I see and learn." You'll see what I mean when you read our special theme-oriented articles this month. (I'm indebted to Bernie Greenberg, a polymath friend who lives in Cambridge, Massachusetts, for introducing me to that phrase.) Thanks go to Mark Dahmke, Dick Moberg, and Rod Daynes for their help in preparing this issue. ■



You've heard how the personal computer is going to revolutionize the way you work.

So far, the reality hasn't measured up to the promises.

But now there's a remarkable new software package that transforms the IBM Personal Computer into an incredibly powerful management tool (Apple and Xerox owners: read on).

The first totally integrated management software.

There are a lot of useful programs available for personal computers.

Unfortunately, they all seem to use different commands and different ways of storing data. This creates two major problems:

1. Every time you want to add a new function, you have to learn a whole new command language.

2. You may not be able to exchange data between different programs.

But now there's a better way. It's called the MBA, and it was created by a blue-chip management consultant, an MIT-trained systems designer, and some of the country's most experienced business programmers.

For the first time, MBA combines all the essential management functions in one easy-to-use package:

Electronic Spreadsheet. The ultimate financial modeling tool that lets you create a giant spreadsheet of figures and text. Change one number, and every affected item is instantly re-calculated.

Word Processing. Compose, edit, and print any kind of document. Make revisions yourself—faster than you can explain them to your secretary. Because MBA is an *integrated* system, it's easy to incorporate data from its other modules into a report you're writing.

Data Management. A sophisticated electronic filing system that lets you store information—ANY information—then retrieve it, analyze it, and generate reports to your specifications.

Graphic Output. For those occasions when a picture tells your story better than words, you can easily generate clear, readable graphs.

Communications. Tie into your company data center, a financial information service, or virtually any other computer system. MBA automatically retrieves the information you want, and lets you edit or rearrange it with a few keystrokes.

Easy to learn. Easy to use.

MBA's designers devoted great care to giving it a simple, consistent set of commands. So when you've learned one module, you'll immediately be comfortable with the others.

What, where, and how.

MBA is offered through selected computer retailers who have qualified people to demonstrate and answer questions.

It runs on the IBM Personal Computer, with Xerox and Apple versions available soon. But whichever machine you use, MBA will make a dramatic improvement in your personal productivity.

And that's a promise.

Context Management Systems, Inc.
Management software for personal computers.

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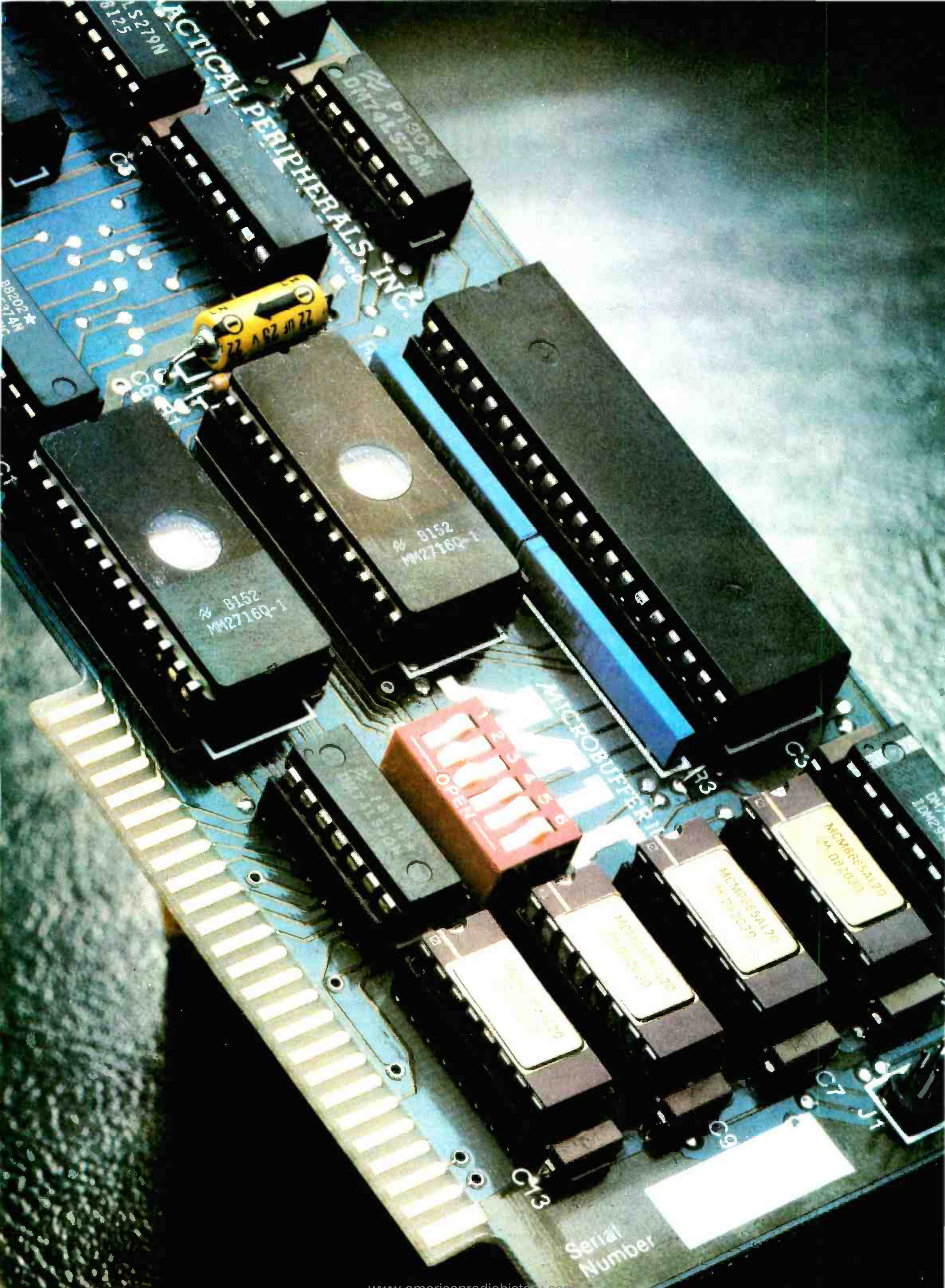
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INTRODUCING MICROBUFFER.

NOW YOU CAN USE YOUR PRINTER WITHOUT WASTING COMPUTER TIME.

Your computer is capable of sending data at thousands of characters per second. But the average printer goes no faster than 80 characters per second.

This means your computer is forced to wait for the printer to finish one line before it can send the next.

A waste of valuable time.

THE NEW MICROBUFFER™ INCREASES YOUR EFFICIENCY.

Microbuffer allows you to print and process simultaneously. No waiting!

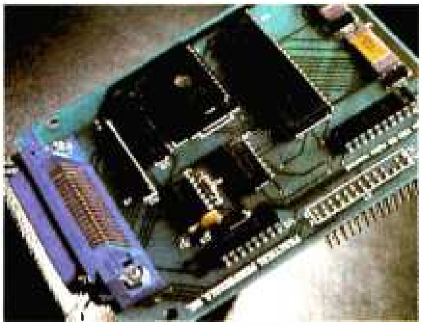
MICROBUFFER ACCEPTS PRINTING DATA AS FAST AS YOUR COMPUTER CAN SEND IT.

Microbuffer first stores the data in its own memory buffer and then takes control of your printer. This frees the computer for more productive functions.

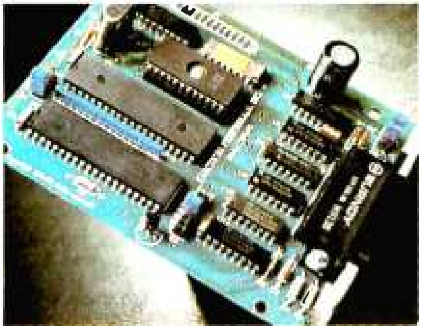
Additional output may be dumped to the buffer at any time and it will be printed in turn.

Microbuffer — a must for any program that requires printed output.

PARALLEL, SERIAL OR APPLE II.



MICROBUFFER MODEL MBP-16K™ is a Centronics-compatible parallel interface for your Epson printer with 16,384 bytes of on-board RAM for data buffering.



MODEL MBS-8K™ is a full-featured RS-232C serial interface for your Epson printer with both hardware and software (x-on/x-off) handshaking, baud rates from 300 to 19,200 and a 8,192-byte RAM buffer.

MICROBUFFER II™ (pictured on the left-hand page) is a Centronics-compatible parallel interface for the Apple II computer with up to 32K of on-board RAM for data buffering as well as on-board firmware for text formatting and advanced graphics dump routines.

SIMPLE TO INSTALL.

Microbuffer MBP-16K and MBS-8K mount easily in the existing auxiliary slot directly inside the Epson printer.

Microbuffer II, being slot-independent, will fit into any slot directly inside the Apple except zero.

MICROBUFFER FROM PRACTICAL PERIPHERALS.

When you think of how much time Microbuffer will save, can you afford *not* to have one?

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Letters

Outsailing the Software Pirates

In the old days, sailing ships had problems with pirates. Two great nations used opposite solutions to reduce the piracy. Spain increased the cannon and armor on its ships. This increased the cost and the weight of the vessels, which slowed them down and made them less desirable as shipping vehicles. England did the opposite. It lightly armed its small, inexpensive ships, thus making them lighter and faster than the Spanish ships. They were better at their intended purpose—to trade and deliver cargo quickly. History has shown us that England won, not because it avoided pirates better than Spain, but because it did not let pirates get in the way of good business—in this case efficient shipping.

This bit of historical fact has great import in the software piracy problem of today. Many software companies are spending too much time and money trying to defend themselves against pirates. They reduce, if not ruin, the usefulness of their products with locked disks, unlistable programs, secret source code, hidden locks, codes in ROM chips, full-page advertisements devoted to discouraging pirates (e.g., Atari), and so forth. These devices have made many programs inefficient and costly to produce and support. Buyers are greatly taxed because they cannot make modifications or backup copies of the programs they have purchased. Often they are inconvenienced by added expenses for backups or future modifications. This hurts sales and angers good customers.

There is a better way, as exemplified by our company, Andent Inc. We produce Apple II software for health professionals (medical and dental systems, appointments, hypnosis, and so on). We have been in business since 1978, which makes us one of the oldest software houses for microcomputers. We are making a profit and always have. We pay our bills and our programmers on time. All our software is unlocked and can be copied for backup purposes. We support all sales by offering free replacement of damaged disks. All our software is listable and can be modified by the user.

We do business in this way because it pays. It pays us, and it pays our customers for buying our software. Because our software is unlocked, customers have little or no trouble with backups (you make your own); updates (we mail out a letter with changes); expensive phone calls (documentation and listings tell you how to make program modifications); disk recalls; changes in DOS; printer-slot and special-character problems; or equipment incompatability due to unusual interfaces, old computer models, and so forth.

Our customers like this. They are buying a program, not a software lease. They have immediate support because changes and problems can be handled over the phone or by letter. Customers can back up programs immediately and as many times as needed. They like our low prices. Unlocked software is good for business—our business, your business, and the customer's business.

But what about pirates? Large-scale pirates, those enterprising souls who copy our programs and sell them worldwide, are discovered and given an option to become our dealers and pay us a royalty on distributed software or meet us in court. As in the old sailing days, reformed pirates (privateers) make the best dealers and we don't mind sharing the wealth. For those who don't want to cooperate, we look to history for the remedy. The English and Spanish both learned that a few executions were good for the morale of the troops. Small-time pirates, the sort who give program copies to their friends, can be controlled by low program cost, registration, and continuing updates and documentation. It just doesn't pay to get our programs secondhand.

Andent Inc. believes that a sale of software is just that—the sale of programs, listings, source code, and backup capability—a complete sale. Our customers do not buy a disguised lease—they buy and own our products. We do this because locking programs is very expensive and time consuming and hurts sales.

It is time for the industry to realize that, as with the sailing ships of old, our prime business is producing and distributing a product, not fighting pirates.

E. J. Neiburger, President
Andent Inc.
1000 North Ave.
Waukegan, IL 60085

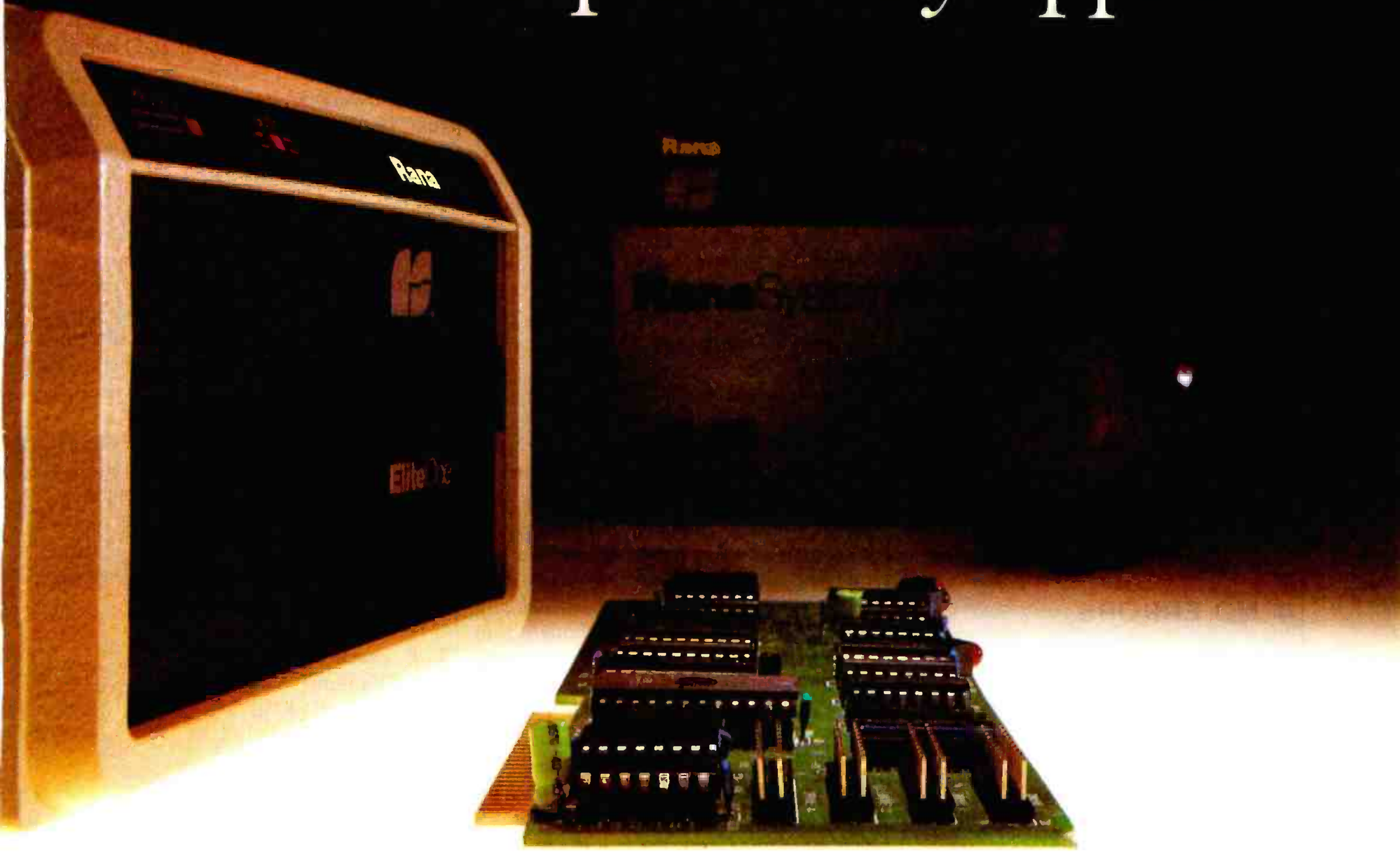
In conjunction with the release of The Graphics Magician and the updated Complete Graphics System II, Penguin Software is announcing a new policy with our applications software for the Apple. The Complete Graphics System II, Special Effects, and The Graphics Magician will all be available now on nonprotected disks.

We've been torn between two points of view. As computer users, we appreciate the ability to have several working copies of our applications software and the ability to go in and modify the code, if desired. We'd use programs such as Visicalc or DB Master for dozens of other applications if we could have them running off several separate disks and didn't have to guard our master copies with such extreme care. Being programmers also, occasionally we'd like to adapt a program slightly to fit our systems' needs or our personal needs. On locked disks, much of a software product's potential goes untapped.

On the other hand, as publishers we've been drawn into the prevailing point of view that lack of copy protection means greatly decreased sales due to casual piracy. This is not just a crazed overreaction; we've all been to user-group meetings, homes of acquaintances, and even some computer stores where we've been aghast at the almost encouraging attitude toward reproducing copyrighted software, most of which took authors months, maybe years, to perfect. The real scare here is that many of us have decided to take a risk on a very new industry and trust our livelihoods to it. Suddenly, individuals out there become statistics, some of which say that for every nonprotected program sold, there are least a dozen pirated copies. Those numbers indicate a cut in sales that could really play havoc with the software producer's ability to pay the bills. Scary? Yes.

From these conflicting points of view, our desire to make a good product better won (but not by much) over our fear of tampering with something that is already going well. Our policies, from pricing to support, have always been very consumer-oriented. Ultimately, it is from that viewpoint that we decided to go ahead with removing the program protection. We feel that you, the consumer, are entitled to software as useful as possible for the money you spend. Our hope is that the added convenience will result in more

It's the best part of any Apple.



Your Apple computer can grow from ordinary to awesome in a matter of minutes.

The Elite disk drive Series by Rana Systems *gives* you that kind of magic. Quickly, easily and cost-effectively.

This superb family of sophisticated floppy drives was designed and perfected by a team of industry-respected engineers expressly for Apple® computer owners who have long been demanding more disk drive for their money.

Now they *have* a drive that makes an Apple perform the way it should. For example;

Elite One, the most economical Rana drive, delivers 15% more storage capacity than Apple's drive. The top-of-the-line Elite Three will provide an astonishing *four-times* more storage, approaching hard disk performance. It's done through exclusive high-density single and double-sided disks and heads.

Here's a tantalizing taste of just how formidable your Apple can become.

Next to enormously increased disk space, Apple buyers are most excited about Rana's fingertip Write/Protect feature. A pushbutton on the LED-lit panel gives you a new measure of failsafe control.

While Elite drives are all plug-compatible with Apple's controller, Rana's vastly superior controller card is a *must* for those with growing data processing demands. With it, you control up to *four* floppy drives using only one slot. . . while still utilizing your Apple computer to achieve dramatic new heights of system flexibility and processing power.

A specially programmed Rana utility disk assures you of far-reaching compatibility, and extra dimensions of business, leisure and learning applications with your Rana-enhanced Apple computer.

There are many, many more operating refinements: Uncanny head-positioning accuracy, 300% faster track-to-track speed, better operating economy, and gentler clamping action through an all-new diskette centering cone, to name just a few.

A disk drive package like this doesn't grow on trees, so write or call today for more information about the Elite Series.

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sales, not less, and that the software market has matured to the point where people realize that the result of illegal copying is less convenience for everyone. We hope that people will think twice before accepting copies from friends, and we hope to be able to continue this policy and start a new trend toward improved usability of all applications software. Please don't abuse our trust in you.

Mark Pelczarski, President
Penguin Software
830 4th Ave.
Geneva, IL 60134

Someone once made the point that many of the positive connotations of "software piracy" disappear when you call it, simply, "stealing." Copying software that you have not paid for is stealing, not adventurous pirating (yo-ho-ho), and I think that few of us will actually make that illegal copy if this thought is in our minds. (Please note that I am saying nothing against making backup copies of disks that we have paid for.) The decision made by Mr. Neiburger's and Mr. Pelczarski's companies is indeed a brave one, one that has been called for by no less a person than Mike Markkula, president of Apple Computer Inc. We at BYTE applaud this decision, encourage more vendors to do the same, and stress the necessity of all consumers to refuse to copy or accept software they have not paid for. . . . G. W.

Of Paperbacks and Program Protection

I continue to read with interest the controversy over program protection. I haven't seen much awareness that this is not a new problem nor a problem unique to the computer industry. Like the similar problems that occurred in the book industry with the advent of the copier and in the record industry with the advent of relatively low-cost, high-quality home music taping, I am sure this one will work its way to resolution.

Certainly I believe that the cost of most computer programs is too high for the personal computer user. I am one, and my case is typical: I had my computer for almost a year before I could justify purchasing a commercial program. While I'm very pleased with the product, I'm simply not about to pay over $100 apiece for many programs.

The problem right now is volume. I can appreciate how much work goes into a really high-quality program, and I believe the author should be fairly compensated. But software producers should consider that 10,000 copies sold at $20 per copy will return him almost the same amount as 1000 copies at $200 per copy. A high volume of sales explains why the book industry now loves rather than hates low-cost paperback books. With the growing number of computers out there, the demand for programs will grow. The competition will also grow as all those computer owners take a fling at writing a commercial program so they can write off their computers at tax time.

With a little patience on the part of software vendors, the problem will resolve itself. In a few years, programs will be as available as paperback books and priced as reasonably. People will buy them rather than copy them because copying won't be worth the trouble.

L. P. Leach
2250 Woodruff
Idaho Falls, ID 83401

Let the Buyer Beware

Congratulations on Gregg Williams's very informative article, "A Closer Look at the IBM Personal Computer" (January 1982 BYTE, page 36). It certainly makes this machine appear very attractive, despite the minor product-availability problems mentioned in the article (many of which have since been answered by advertisements in BYTE).

I would like to make a few comments about IBM's product-identification and pricing policies—questions I feel Mr. Williams could have addressed more completely in his article. The first concerns the IBM matrix printer. In photo 1 this item appears very similar to the Epson MX-80, a suspicion which has since been confirmed by a local IBM Personal Computer dealer. The article might have mentioned that the Epson printer is available from various retail and mail-order dealers for savings of $100 to almost $300, and that the only difference between the Epson and IBM variations is the case color. IBM tacitly admits to the interchangeability of the units by marketing its printer cable separately.

I have a similar, though presently unconfirmed, suspicion concerning the IBM floppy-disk drive. Inspection of this

PICK A WINNER

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1 **Bank Selectable S-100 128K Memory.** Systems Group's new 128K dynamic memory board has eight independent 16K software selectable memory banks, each addressable on any 16K boundry. It's jumper selectable so you're not PROM locked in to any one configuration. And with more advanced features, it's the most flexible in the industry.

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3 **Eight-Inch Add-On Floppy Disk, Hard Disk, and Tape Drive Subsystems.** This series was created to provide a full range of mass storage products to complement the System 2800 computers. The subsystems also offer universal systems expansion to the users of other S-100 systems.

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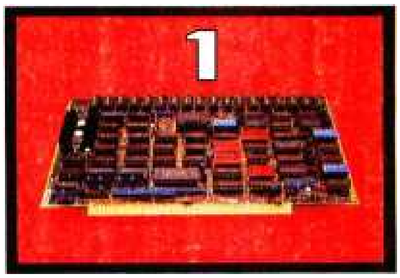

4 **Series 2800 Business Computers.** Systems Group offers a choice of expandable systems with dual floppies (up to 2.4M Bytes) or hard disk (up to 40M Bytes) w/ floppy (1.2M Bytes) or tape (20M Bytes) for back-up.

5 **Expandability.** Add-on memory, I/O and drive subsystems means never being trapped into systems without flexibility. With Systems Group's reliable designs you can add more floppy and hard disk drives or tape back-up for increasing mass storage requirements. Add more memory and I/O for up to 12 independent users per system. Choose from Super CP/M, MP/M II, or OASIS operating systems.

Come to Systems Group for any of your microcomputer needs. Everything from our new 128K Memory Board to complete systems. We're helping make computers what they should have been in the first place.

All Systems Group's products are warranteed for one year. Ask about our 30 day dealer/OEM evaluation policy.

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Turn your TV into a time-sharing videotex display for $399.*

Now you can connect your family to the informative and entertaining world of CompuServe, The Source, Dow Jones News/Retrieval and other time-sharing and data-base networks.

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RCA

item (see, for example, the IBM advertisement in the February 1982 BYTE, pages 24 and 25) suggests that this drive is component-for-component identical to the Tandon 100-1 5¼-inch drive currently available from various suppliers for approximately half the IBM drive's price. The IBM Personal Computer *Technical Reference* manual should clear up this question (I'm presently awaiting the arrival of my copy), but a recent advertisement from VR Data Corporation (February 1982 BYTE, page 181) suggests that these drives are indeed equivalent. Of course, one is still left wondering whether installing such drives would void the warranty.

In both these examples the IBM "unbundling" practice referred to in Mr. Williams's article may serve the knowledgeable buyer almost as well as it does IBM—buyers aren't restricted to purchasing the peripherals from IBM because the interface cards (and the printer cable) are available separately. Though I suppose it's a case of *caveat emptor*, I think readers of the article would have been better served if at least the printer question had been addressed.

As Mr. Williams said in the article, the IBM pricing strategy may easily become a source of hard feelings among users down the road. The present IBM policy of offering 40 percent discounts to its employees (see "BYTELINES," February 1982 BYTE, page 328) makes the company's high prices particularly questionable because one doubts if IBM is so altruistic that it will take a loss on these sales.

I've been an avid reader of your magazine since 1978, and I don't feel that these complaints imply a lower quality or objectivity in Mr. Williams's article as compared to that of any of the similar, excellent product reviews BYTE has previously published. I am disappointed, however, in IBM's apparent attempt to gouge its customers, because the typical buyer often approaches buying a system in terms of "how much can I get for $3000?" and will spend any money left over on more hardware or software from the same source. At least that's the case with me, and I'm still interested in the IBM Personal Computer (especially if I can buy and install Tandon drives in my system and still get service from IBM).

Louis C. Kovacs
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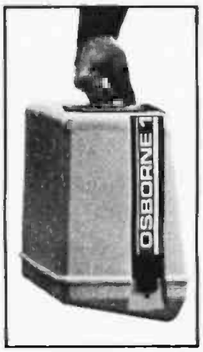

OSBORNE 1

The Price Is Right

Was I the only new CP/M user with a Z80 processor who was surprised (not to say annoyed) to learn that I could not assemble Z80 code with the CP/M assembler? I immediately searched for a Z80 assembler, but I was astonished at the prices for such a basic utility (e.g., $162 for Macro 80 from Microsoft).

I have now discovered a small company with just the Z80 assembler I wanted at the price I wanted to pay, and I think other BYTE readers might like to know about it. The company is Software Toolworks (14478 Glorietta Drive, Sherman Oaks, CA 91423), and someone there patiently answered my questions on the phone and then shipped my order very promptly.The product is the utility UV-MAC, a macro assembler for the Z80, and it costs $29.95. It's fast and has macro definitions and all the options most of us will ever need. Also included is an even faster stripped-down assembler (AS) with no macros. Altogether, it's a really fine package.

The Software Toolworks offers other software (languages, utilities, games, and editors) all in the $24 to $39 range. This could be the beginning of the end of outlandish software prices! I recommend the company highly.

Dr. David L. DuPuy, Associate Professor
Department of Astronomy
Saint Mary's University
Halifax, Nova Scotia
B3H 3C3 Canada

In Praise of Elegance

After debugging my typing, I feel Edward Heyman's FIT program ("FIT—A Federal Income Tax Program in UCSD Pascal," February 1982 BYTE, page 148) is one of the best ever to appear in a magazine and is a masterpiece tutorial on the elegance of Pascal. Christopher Morgan, the editor of BYTE, deserves commendation for recognizing the merit of the program and for devoting pages in his very popular magazine to the publication of the source code.

The program as published for calendar-year 1980 really works. In only a few minutes, I entered all the figures from my 1980 tax return and got a result which agreed with my hand calculations to the penny (no mean feat). That in itself justified the two rainy days I spent typing in the 1328 lines of source code for the main program. The auxiliary programs involved a fair amount of typing, but they were much easier than the main program.

Even more important than its being a working program is its excellence in illustrating the versatility and beauty of Pascal. It covers formatting, linked lists, extended precision using strings, files, data types, elegant algorithms, etc. I shall be studying it for months as a sophisticated use of the language and as a tutorial. It will, of course, have to be modified for 1981, but the beauty of the program and its lucidity is such that anyone with even a conversant knowledge of the language will be able to modify it.

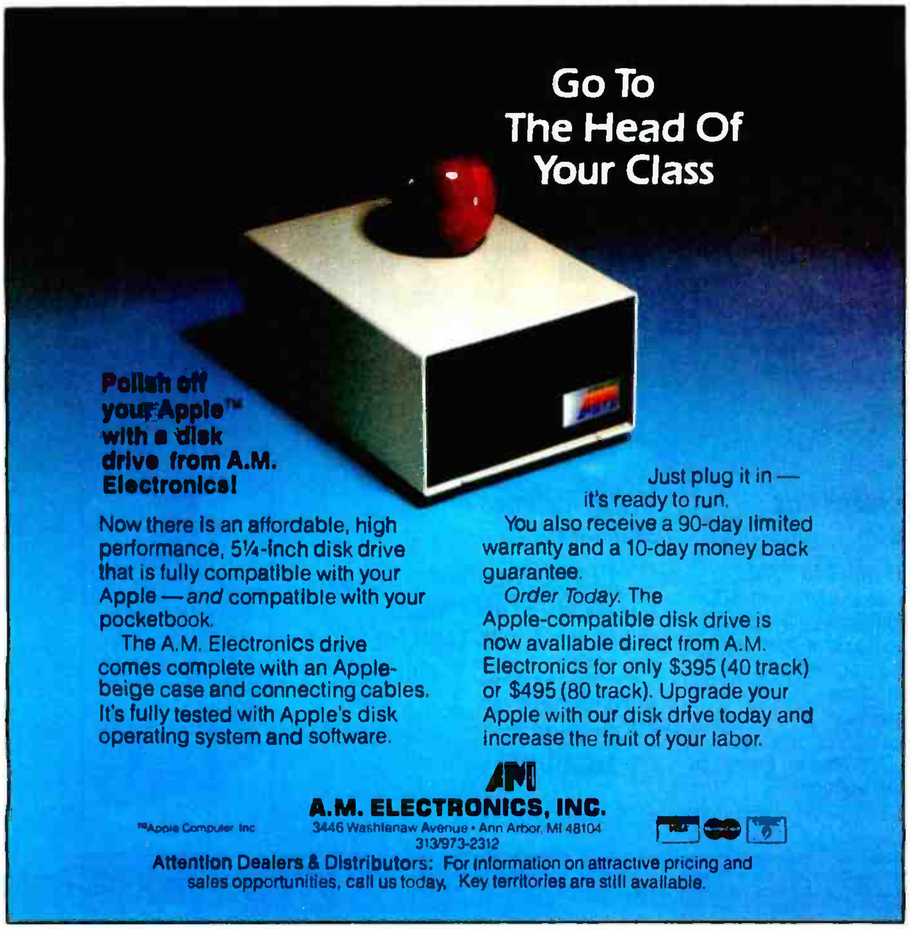
I recently purchased a text which purported to be a guide to Pascal for engineers. It totally ignored the subtleties of the language and made no bones about it. All it aimed to do was translate old BASIC or FORTRAN programs to Pascal, totally ignoring the major intent and purpose of Pascal. Instead of "think Pascal," the attitude was "think FORTRAN and translate to Pascal."

Anyway, Mr. Heyman's kindness in contributing an article with professional merit if not, perhaps, marketability, is much appreciated by those whose main interest is computer languages.

Albert Weinshelbaum, M. D.
9 Merrimac Court
Danville, CA 94526

Simplifying Apple PIAs

I have been homebrewing with 6800-series devices for several years now, and I have some comments on Kenneth J. Ciszewski's fine hardware article "Add a Peripheral Interface Adapter to Your Apple II" (January 1982 BYTE, page 324). While the circuits in figures 1 and 3 of the article will work for interfacing a 6520 PIA (peripheral interface adapter) to the Apple, the 74LS04 chip could be eliminated from both circuits. In both figures,



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the CS0 and CS1 inputs of the PIA can be tied directly to +5 volts. In figure 1, the active-low CS2 input can be ungrounded and connected directly to the active-low Device Select line. In figure 3, the CS2s will stay connected to the 74LS42 decoder as indicated. Pin 12 (D) of the 74LS42 can be ungrounded and connected to the Device Select line, eliminating the 74LS04 again.

The only other thing I note is that the CA1, CA2, CB1, and CB2 lines from the PIA are shown tied to +5 volts through 1000-ohm resistors. These lines can be very handy to use as handshaking signals, especially with a Centronics-compatible printer interface. The CA2 (or CB2) is used to send a Data Ready signal to the printer, while the CA1 (or CB1) is used to receive a Data Accepted signal from the printer. The states of these lines are set and read through the control registers in the PIA under software control.

Randy L. Kron
Route 2
Kalona, IA 52247

Cruel but Fair

In Robert Moskowitz's review, "Missile Defense vs. ABM" (December 1981 BYTE, page 80), the author regrets that Muse Software's ABM did not restore cities and that in On-Line Systems' Missile Defense the enemy continued to destroy cities after the defender ran out of ammunition.

I agree that these features are unsportsmanlike and may make the game less fun, but they are, if nothing else, very realistic.

R. S. Peterson, Commander, USN
1116 Davidson Rd., Apt. 133
Nashville, TN 37205

Algorithmic Roots

I enjoyed David R. Borger's letter (see "Faster Algorithms," February 1982 BYTE, page 18) describing a fast method for shuffling cards, and I can provide a source for this algorithm. It can be found in *Combinatorial Algorithms*, Second Edition, Albert Nijenhuis and Herbert S. Wilf (Academic Press, 1978). This book contains program listings and extended discussions of many related algorithms of potential interest to BYTE readers.

Dave Bayer
33 Cherry St.
Somerville, MA 02144

Seeking Fellow Explorers

I am interested in joining a users group catering to Netronics Explorer 85 owners. Can you or any of your readers put me in touch with one? If there is none, I would like to hear from anyone out there interested in forming one.

Clarence Heier
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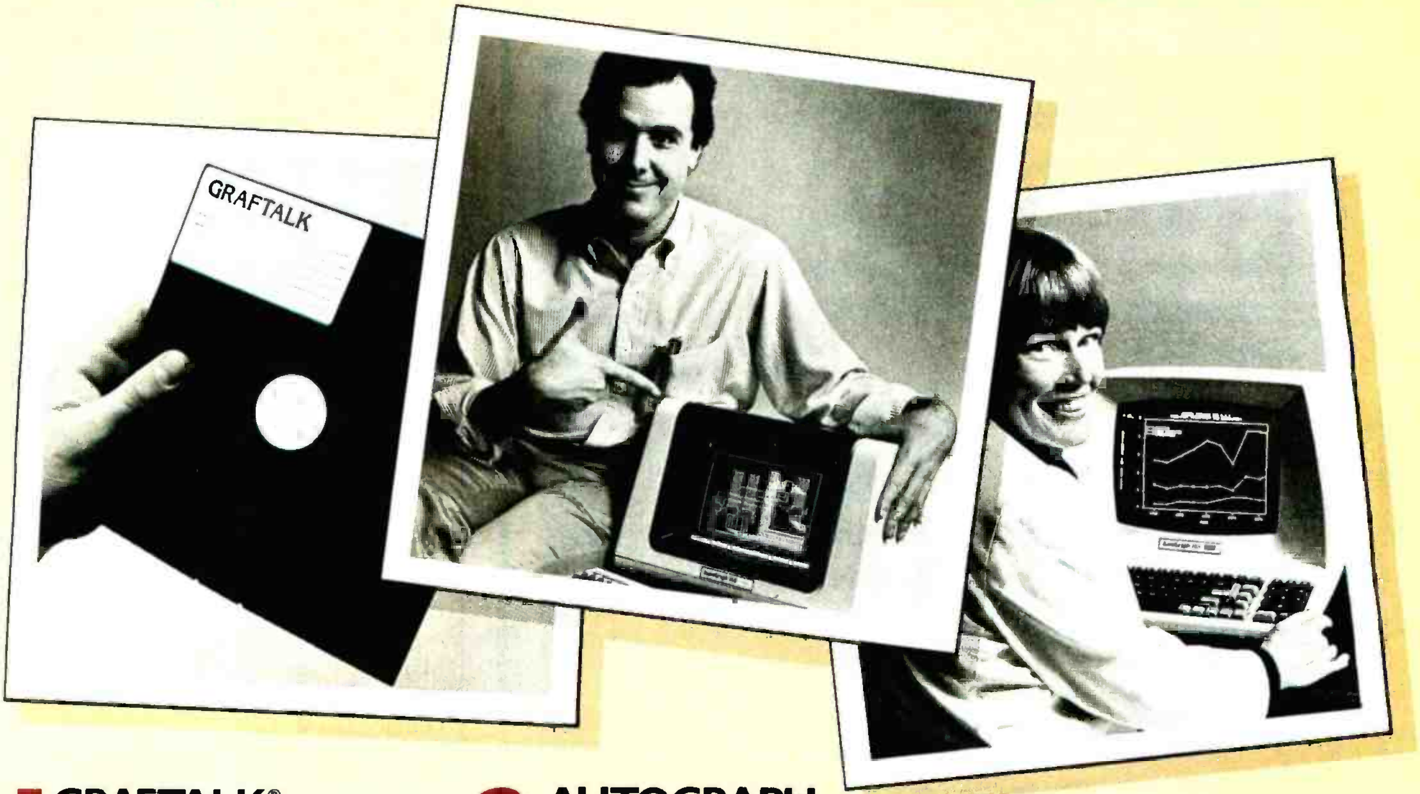

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Brewing Up an Interface

I was fascinated to read "A Homebrew Graphics Digitizer" by Neal Atkins and Enrique Castro-Cid (February 1982 BYTE, page 72). I would like to construct such a device, but my technical skills being what they are, I am not able to design the proper way to interface it with my Atari. If any of your readers could be of assistance I would greatly appreciate the help.

Scott Berfield
5816 North Sheridan Rd., 2F
Chicago, IL 60660

Keep It Technical

I object strenuously to your decision to include in your Letters column of the February 1982 BYTE a letter on page 30 from Steven Pacenka.

I buy technical journals for technical information. I believe that an antinuclear faction's ideas no more belong in the pages of BYTE than do any other views on moral or social issues.

Perhaps you feel that this type of rhetoric has a place in your journal. If your answer is yes, than I can certainly exist without BYTE.

Martin J. Weitzman
POB 1153
Loomis, CA 95650

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In his review "The Flexibility of VisiPlot" (February 1982 BYTE, page 32) Robert E. Ramsdell claims that its companion program, VisiTrend, "is the most powerful forecasting and analysis software presently available." This is not true.

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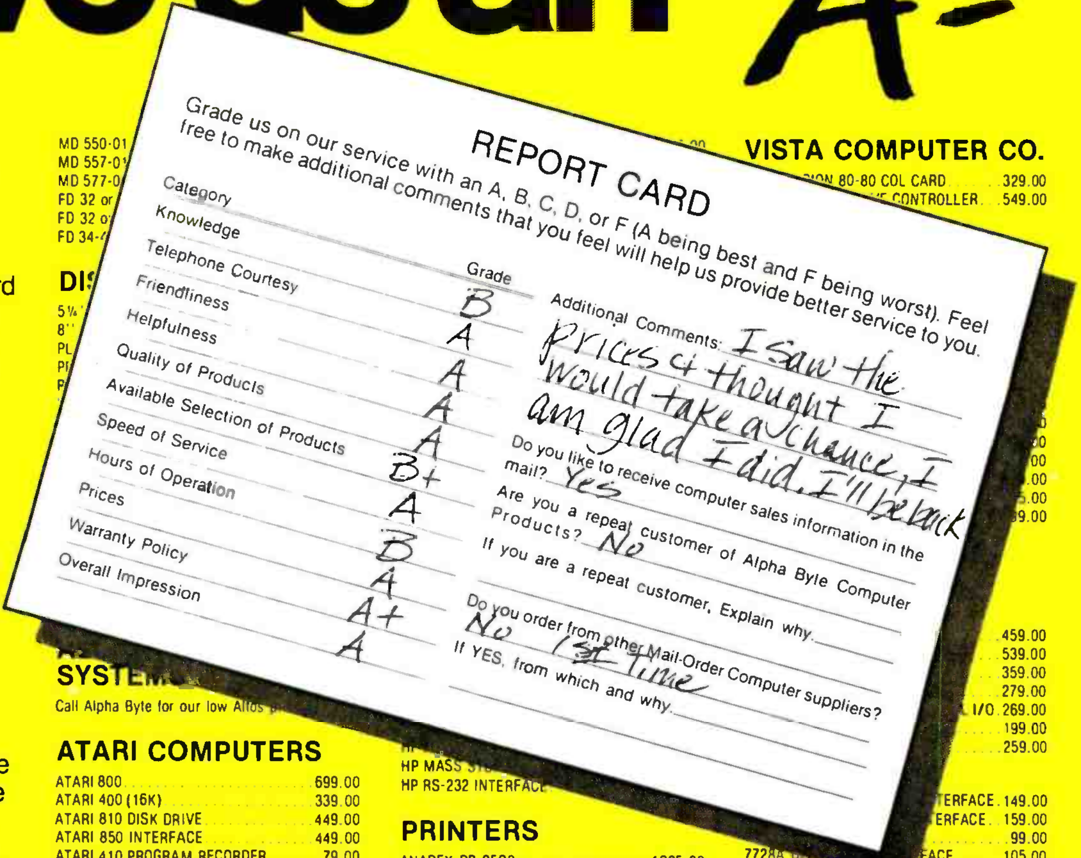

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microcomputer (also advertised in BYTE), which implements the Box-Jenkins technique. This method is usually able to forecast commodity prices within 1.5 percent of the actual price.

Perhaps the only thing more powerful about VisiTrend is the company that sells it.

Eric Weiss, PhD
The Winchendon Group
3907 Lakota Rd.
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Alexandria, VA 22310

ARCNET Speed Correction

The January 1982 BYTE (see "BYTELINES," page 296) carried a short piece about Tandy Corporation's ARCNET local-network system and its basis in Datapoint Corporation's Attached Resource Computer (ARC).

I enjoyed the article and appreciate the coverage. However, an error was made in reference to ARCNET's speed. The article stated that ARCNET operates at 21.5 megabytes per second. This is incorrect; ARCNET operates at 2.5 mega*bits* per second.

Gerard L. Cullen, Vice President
Corporate Communications
Datapoint Corporation
9725 Datapoint Dr.
San Antonio, TX 78284

More Memory for the ZX80

I would like to correct one detail in Hilton K. Ernde's article "Memory Expansion for the ZX80" (January 1982 BYTE, page 216). Mr. Ernde notes that the ZX80, when powering up, will not recognize more than 16K bytes of RAM (random-access read/write memory). This is true but not as restrictive as one might think.

The ZX80 (and ZX81) can be forced to recognize up to 48K bytes of RAM. On the 8K-byte ROM (available as an option for the ZX80; standard on the ZX81), this is simply accomplished by using POKE statements to place the address of the last byte of memory plus 1 (i.e., the address of the first nonexistent memory byte) into the system variable RAMTOP (addresses 16388 and 16389). The system-initialization code can then be called directly from BASIC with the statement RAND USR

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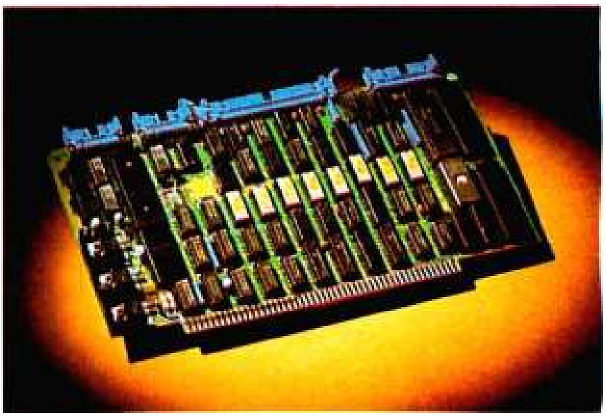

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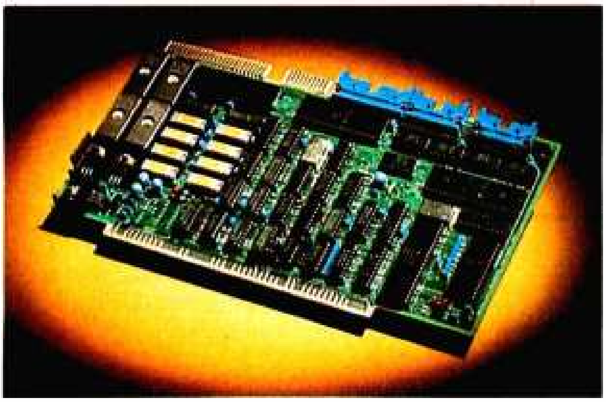

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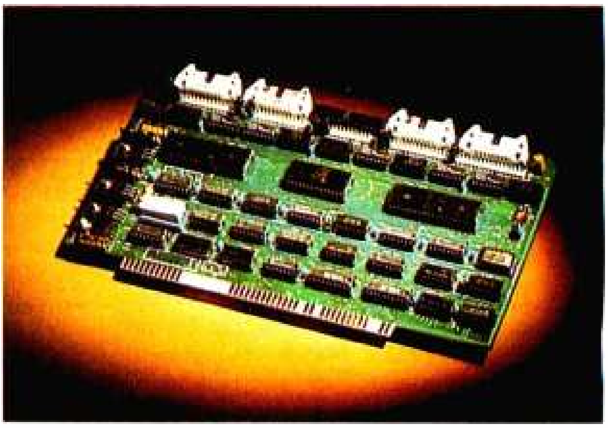

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Letters

997. The machine will then reinitialize, placing the stack at the end of memory.

On a ZX80 with the 4K-byte ROM, the same result can be achieved with slightly less ease. The 4K-byte ROM has no RAMTOP system variable. It is thus necessary to write a short machine-code routine to perform the parallel function. The following code will initialize the ZX80 (4K-byte ROM) with up to 48K bytes of RAM:

```
LD    A,$3F
LD    HL,$BFFF; For 32K
JP    INIT     ; @$26B
```

Heuristics of Massachusetts is a company devoted to supporting the Sinclair line of computers. We are attempting to fill what we see as the one hole in the Sinclair domain—information and documentation. It is nice to know that we aren't the only people who feel that this hole exists.

David B. Ornstein, President
Heuristics
25 Shute Path
Newton, MA 02159

A Fix for GEOSAT

I would like to take this opportunity to thank the many people who have written or called me with comments and questions on my article "The GEOSAT Program" (January 1982 BYTE, page 420). In particular, I would like to thank Mike Flaherty of Miami, Florida. While running the program, he created a condition for which I had failed to check. That condition occurs when a zero latitude is entered by the receiver position (i.e., the receiver is on the equator). In that case a division-by-zero error occurs.

To fix that one case, the following code should be entered at line 299:

```
299 If L1 = 0 then L1 = 1.0E-4
```

I would also like to thank Cedrig Onsruth of Merrimack, New Hampshire. Because of discussions with Cedrig, I will be adding some enhancements to the computational section of this program.

If anyone is interested in obtaining the derivations of the formulas used in this program, I will be glad to send them a copy if they would supply me with a self-addressed, stamped envelope.

Steve Emmett
12816 Tewksbury Drive
Herndon, VA 22071

In Search of Faster Modems

This letter concerns itself with the questions of modem transfer speed, cost of high-speed modems, and transmission protocols. It is quite clear that the standard 300 bits per second (bps) Bell-103-compatible modem has become extremely popular in the microcomputer community. However, as is probably very obvious to those who use these modems frequently, 300 bps is quite slow. Although 1200-bps modems do exist, they can cost as much as eight to ten times that of a 300-bps modem. Furthermore, there are two different protocols for 1200-bps communication: Bell 212A and Racal-Vadic protocols. Thus what we really need are

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the so-called "triple" modems which support data rates of 300 bps and 1200 bps under both of the above protocols. With 1200-bps communication, phone costs are reduced accordingly and interactive programming is much more feasible. (With appropriate data compression, e.g., Huffman coding, an additional transmission-speed factor of 2 can be obtained on many types of redundant data such as English text and ASCII files.) My point is that some innovative company should break the $800 price barrier and provide us with higher-speed modems. I believe that the demand would justify the undertaking.

Anthony Skjellum
1695 Shenandoah Rd.
San Marino, CA 91108

Because they work in both the digital and analog domains, modems must deal with subtle problems that occur only at the intersection of these domains. The binary phase-coherent FSK (frequency-shift keyed) transmission method of the low-speed Bell 103 modem is limited in its transmission speed by the bandwidth of the two-wire telephone line. To pack more bits into the same bandwidth, a faster modem must modulate its data in some other way.

The Bell-212A and the Racal-Vadic protocols are the two most commonly employed for full-duplex medium-speed 1200 bps transmissions; both are variants of a technique called quadrature amplitude modulation, or QAM, which is a four-level PSK (phase-shift keyed) protocol. (A somewhat older protocol, used by Bell-202-type modems, works only for half-duplex transmissions, where "half-duplex" means that transmission of data occurs alternately in two directions over the same two-wire link. Bell 202 modems have often been used over four-wire links, so that transmission in both directions can proceed simultaneously.

In 1973, before the Bell 212A had been introduced, Racal-Vadic developed a protocol for its VA3400-series medium-speed modems that allowed full-duplex 1200-bps transmission over two-wire connections. Three years later, the Bell System brought out the 212A modem, which incorporated a different design methodology and was not compatible with the VA3400 protocol.

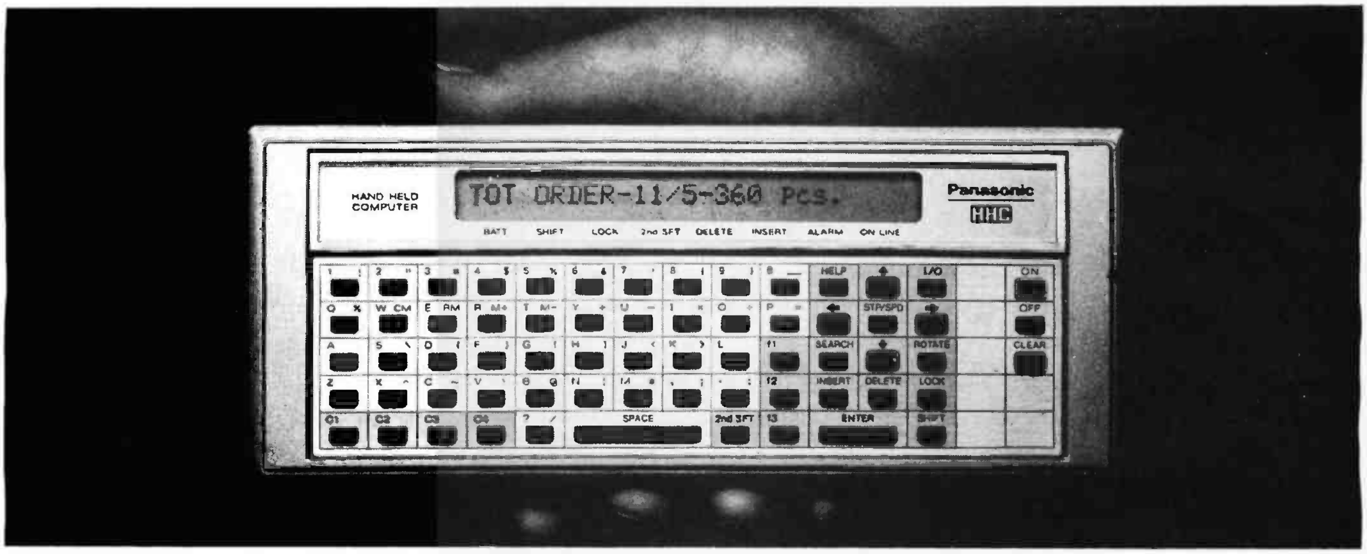
An originate-mode 212A transmits on a carrier frequency of 1200 Hz, on which the data bits are phase-shift modulated, and the answer-mode 212A transmits on a carrier at 2400 Hz. Many telecommunication engineers have objected to Bell's choice of frequencies, because the answer-mode transmission frequency is exactly the second harmonic of the originate transmission frequency. Second-harmonic distortion is quite common in analog circuitry in general and is pandemic in telephone handsets. Therefore, making an acoustic-coupled version of the Bell 212A is extremely difficult, because the telephone handset may fool the modem into thinking that the answer carrier is present when it is not.

In contrast, Racal-Vadic set up its originate-mode dataset to transmit its carrier tone at a frequency of 2250 Hz, while its answer-mode counterpart transmits on a carrier at 1150 Hz. The originate modem is never in danger of being fooled by the second harmonic of its own carrier, because the harmonic falls at 4500 Hz, well outside the communication passband. Racal-Vadic claims other advantages of its equipment, but the frequency difference is the most fundamental.

Racal-Vadic thinks its own protocol is better, but not wishing to neglect the Bell-compatible segment of the telecommunication market, it developed the VA3451 triple modem, which sells for $900. This device can operate using the low-speed Bell-103 protocol and both the medium-speed Bell-212A and VA3400 protocols. Another firm that makes triple modems is Anderson-Jacobson, which recently announced the Model AJ1233 acoustic-coupled triple modem ($995 for one unit). Perhaps more companies will enter the field and increase the level of competition, but medium-speed modems are necessarily more complex than the low-speed ones.

For further information, contact Racal-Vadic Inc., 222 Caspian Dr., Sunnyvale, CA 94086, (408) 744-0810, and Anderson-Jacobson Inc., 521 Charcot Ave., San Jose, CA 95131, (408) 263-8520.

For information on Huffman codes and other means of compression, see "Text Compression" by James L. Peterson (December 1979 BYTE, page 106), "An Introduction to Data Compression" by Harold Corbin (April 1981 BYTE, page 218) and "An Effective Text-Compression Algorithm" by David Cortesi (January 1982 BYTE, page 397). The problem with text-compression codes is that as yet no particular code has become used widely enough for many people to bother setting up their equipment to transmit and receive compressed data . . . . **R. S. S.**



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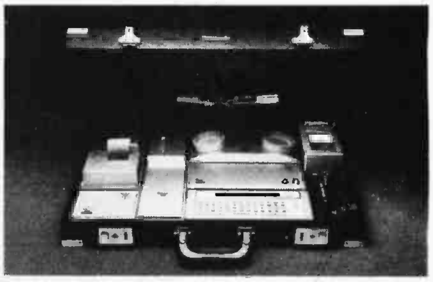
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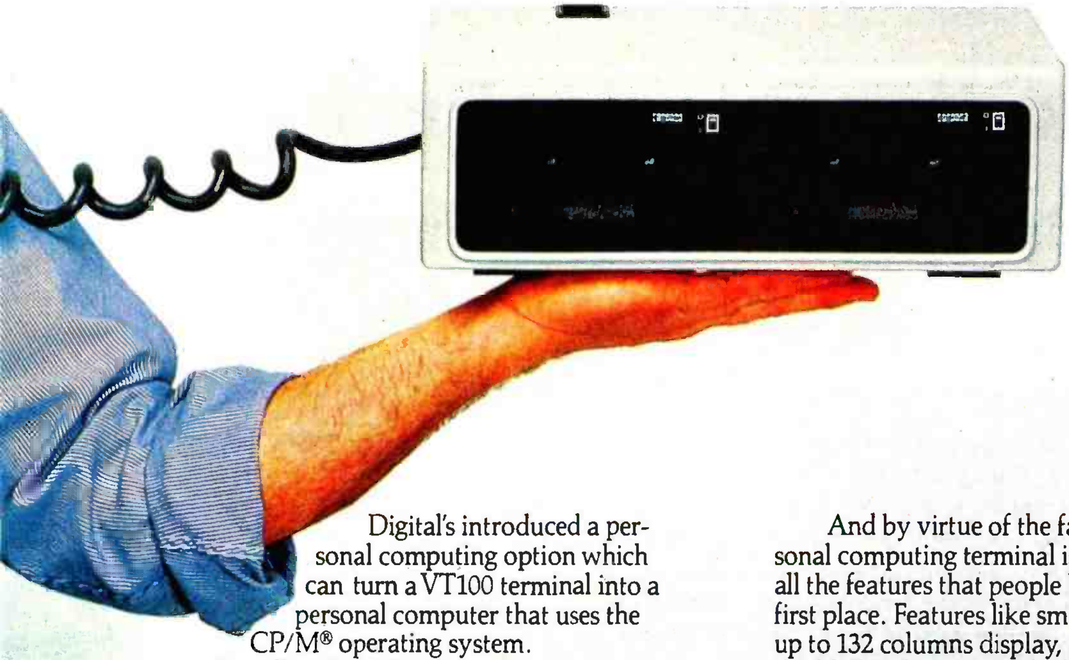

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The Videodisc Interfacing Primer

Learn what it takes to develop interactive videodisc programs.

Rod Daynes
Videodisc Design/Production Group
POB 83111
Lincoln, NE 68501

Imagine yourself as a student pilot in a light plane coming in for a landing. As you make your approach, you see the landing strip through the propeller's arc. The computer informs you of the distance to the field. You glance at the instruments, and then back at the field. The sound of the engine changes as you glide in for the touchdown. You then request a view of the landing as seen from the field. The computer responds to your request, and asks if you want to repeat the landing. Are you flying a super complicated flight simulator? No, you're interacting with a videodisc player interfaced to a personal computer.

This experimental flight-training program developed by the Nebraska Videodisc Design/Production Group uses a realistic visual database from the videodisc player controlled by a TRS-80 Model III, which also provides the text "overlay." The overlay is used to plot running distances between the airstrip and the aircraft; provide additional instrumentation data; and point out tutorial information for the pilot trainee, all "keyed" over the videodisc-player picture (see photo 1).

About the Author

Rod Daynes is the director of the Videodisc Design/Production Group. Starting in 1978, the Office of Science and Technology at the Corporation for Public Broadcasting funded station KUON-TV at the University of Nebraska to investigate the potential of videodisc technology, with special emphasis on interactive and educational applications. Initial funding was used to investigate interactive videodisc applications for the hearing impaired. This resulted in the first two videodiscs ever made with closed captions, providing teletext-like applications for hearing-impaired children. The Nebraska Videodisc Design/Production Group has since developed more than 30 interactive videodiscs covering a variety of subjects.

[**Editor's Note:** *Like all new developments in microcomputers, videodisc interfacing comes complete with its own set of technical terms and jargon. The author has thoughtfully provided a glossary, located at the end of this article, to help decipher these terms. . . .***S. J. W.**]

Another example of computer-controlled interactive videodiscs is Think It Through, a problem-solving

INSTRUMENTS

WHERE ARE YOU IN THE LANDING PATTERN?

1 ENTRY LEG
2 BASE LEG
3 FINAL APPROACH

Photo 1: *An "instrument tutorial" section of a low-cost flight-training system using the "overlay" interface, a TRS-80 Model III, and an optical videodisc player. The text, generated by the computer, is keyed directly over NTSC video (the flight instruments).*

exercise/sleuth-game series developed for hearing-impaired children in conjunction with the University of Nebraska's Barkley Memorial Center (see photos 2, 3, and 4). Designed to incorporate elements of a mystery story and an adventure game, Think It Through uses visuals from the disc and prompts generated by the computer to pose problems for the children to solve. Two discs are in the series, each with a different subject matter. But both use the same basic problem-solving approach: defining the problem, selecting a possible solution, and then testing the solution to see if it works. The game Something's Missing contains 76 different motion sequences. The terrific idea about these games is that when the computer is added, these sequences can be redesigned, frozen, accelerated, slowed down, and treated in an almost infinite variety of ways, which is the heart of the idea behind interactive video.

System Classification

Our general approach to all of this has been from a potential user's point of view. Our main interest is in what it takes to put together a usable system with emphasis on producing the discs themselves. (We have focused almost exclusively on optical reflective discs, otherwise called "constant angular velocity (CAV)," since optical transmissive discs are seldom used and most capacitance discs are not frame addressable.)

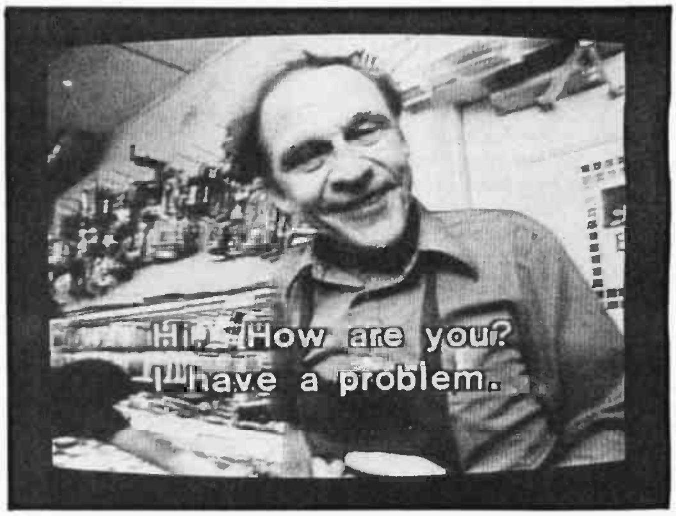
Because so many different types of videodisc players are on the market, we developed classifications based on the functional capabilities of the players in relation to their intended uses:

Level One: This includes "consumer" videodisc players, such as the Pioneer VP-1000 and Magnavox 8000. They are characterized as having individual frame addressability, worst-case frame access (1-54,000) less than 20 seconds, limited memory, and no processing power.
Level Two: These "industrial" videodisc players, such as the Sony LDP-1000 and the Discovision Associates (DVA) PR-7820, have the capabilities of level one, improved worst-case access times (the DVA PR-7820-3 is fastest at less than 4 seconds), two-way player/computer communication capabilities, and a built-in microprocessor.
Level Three: This level includes either a level-one or level-two videodisc player interfaced to a personal computer.

Actually, this classification also has a level zero, which includes players having no inherent capability for still/freeze framing and addressability, such as the CED (capacitance electronic disc) systems and optical discs designated as "extended play," or CLV (constant linear velocity). Also, a level-four group includes even more advanced systems.

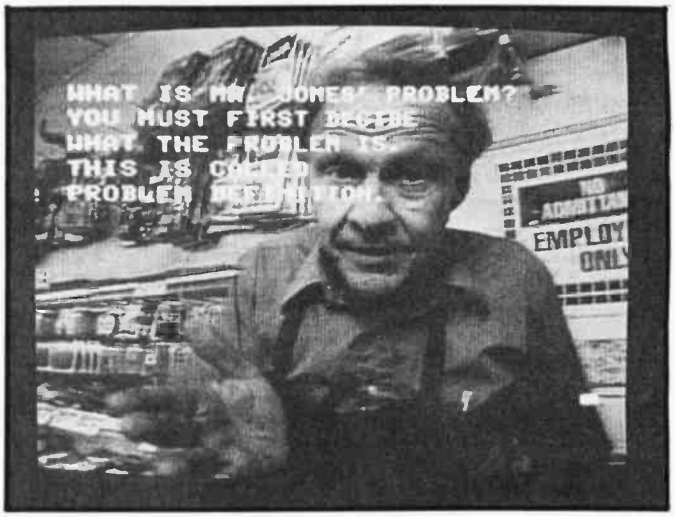
Level One

The principal videodisc player in this category is the Pioneer VP-1000 (see photos 5 and 6). The VP-1000 is



2

3



4

Photos 2, 3, and 4: *These photos are taken from an experimental videodisc/computer sleuth-game series for hearing-impaired children. In this game, called Something's Missing, Mr. Jones, the grocer, sets up the problem (some items are missing from his shelves). Open captions are video generated (photos 2 and 3), and the computer prompts the student via the "overlay" (photo 4).*

	Magnavox Model 8000	Pioneer VP-1000	Sony LDP-1000	DVA PR-7820 1, 2, 3
Still frame	X	X	X	X
Step frame	X	X	X	X
Slow motion	variable	variable	1/5	variable
Fast play	forward x3	x3	x3	
Direct frame access		X	X	X
Scan/search	X	X	X	X
Remote control		option	X	X
Dual audio	X	X	X	X
Pause (CLV)	X	X		
Auto repeat	X	X		
Chapter stop	X	X		
Picture stop	*	X	X	
Programmable			X	X
Digital disc dumps			X	X
Worst-case access (secs)	20 +	18-20	5	2-5
Power	65 W	95 W	95 W	130 W
Weight	28 lb	39 lb	44 lb	54 lb

* With additional circuit board

Table 1: *Comparison of videodisc-system capabilities. The table covers level one and two systems that are not interfaced to a microcomputer.*

Photo 5: *The Pioneer VP-1000 consumer (level-one) optical reflective videodisc player.*

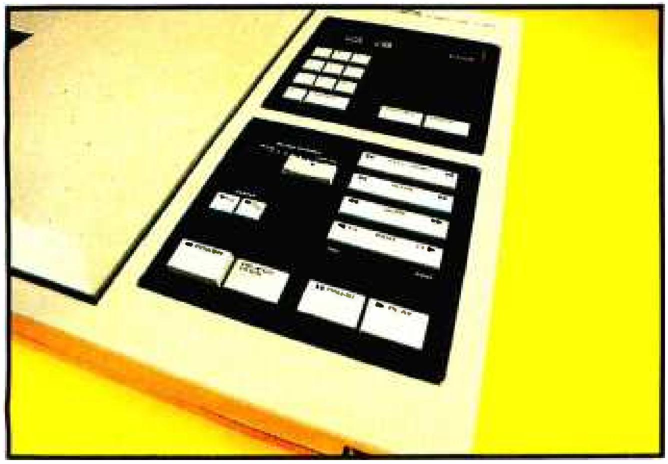


Photo 6: *The Pioneer VP-1000's control panel. The VP-1000 is distinguished from other level-one players by its ability to directly access a videodisc frame and its remote-control unit.*

capable of "searching" directly to any addressable frame on the disc, which is essential for interactivity and external control. Also, it has a remote-control unit, which means that all typical functions of an optical videodisc player (see table 1) come together in one place, the remote-control jack. The Magnavox 8000 is capable of displaying individual frames, but can only grossly access individual frames, much in the same manner as you thumb through a book to find a single page.

The Pioneer VP-1000 can read "picture stop" and "chapter" codes if they are encoded on the disc. A picture stop halts forward play of the disc on the frame where it has been encoded. Currently, with the VP-1000, the frame number has to be displayed. If this is not done, the player will ignore it (this may change in future versions). The Magnavox player requires a special circuit card to read picture stop codes.

The chapter code enables the VP-1000 to directly search to the first frame of a chapter. This is handy if you want to find a particular set of still frames or a motion sequence. The Magnavox player, since it cannot directly access single frames, finds chapters during a "scan" by sampling every 400 frames (also called the "landing pad").

Keep these features in mind. When you finally decide to connect your level-one system to your computer, picture stops and chapter codes can make your programming more economical.

Level Two

Only two level-two videodisc-player systems are currently on the market. The first is the DVA PR-7820 series Models 1, 2, and 3 (see photo 7). Models 2 and 3 differ because of two updates of the 7820's EPROMs (erasable programmable read-only memories). The second system is the Sony LDP-1000 (see photo 8). Sony also has a Model

2 with updated EPROMs. (A third videodisc player, the Thompson-CSF, has yet to get off the ground.) Before the release of the LDP-1000 in 1981, we had been using the reliable DVA players with no real complaints. We are now using both and are quite enthusiastic about the LDP-1000 because it offers some different features.

Level-two videodisc players are distinguished from level-one systems mainly by their programmability. You can program these players, on a limited basis, to execute a set of frame searches and autostops, to wait for input from the user, and to branch back into the programmed instructions accordingly. Programs can be recorded onto the second audio track of the videodisc and loaded into the videodisc player's RAM (random-access read/write memory). Multiple loads are possible, allowing maximum use of available memory.

The DVA PR-7820 Models 1, 2, and 3 contain F-8 microprocessors with 1023 bytes of RAM (initial memory locations per load). Commands and registers are stored in these locations. Each command takes up one byte. For example, if you want the player to find frame 1000, then play to frame 3000, the DVA commands would be:

Bytes	Command	Comment
1	1	
2	0	
3	0	
4	0	
5	Search	Find frame 1000
6	3	
7	0	
8	0	
9	0	
10	Autostop	Play to frame 3000

A more sophisticated program would use registers to accomplish the same task:

Bytes	Program Step	Command	Comment
1		1	
		Recall	Activates register 1
		1000	
		Store	Stores 1000 in 1, activates 2
2		3000	
		Store	Stores 3000 in 2
3	1	1	
4	2	Recall	Activates register 1
5	3	Search	Frame 1000, activate 2
6	4	Autostop	Play to 3000
7	5	Halt	

This is useful if you want to save RAM, especially if your program searches and autostops frequently.

Photo 7: *The Discovision Associates (DVA) PR-7820 "industrial" (level-two) optical reflective videodisc player. The DVA PR-7820's EPROMs have been updated twice (Models 2 and 3), resulting in faster search times and increased user-definable functions. Two-way communication between computer and disc is possible.*

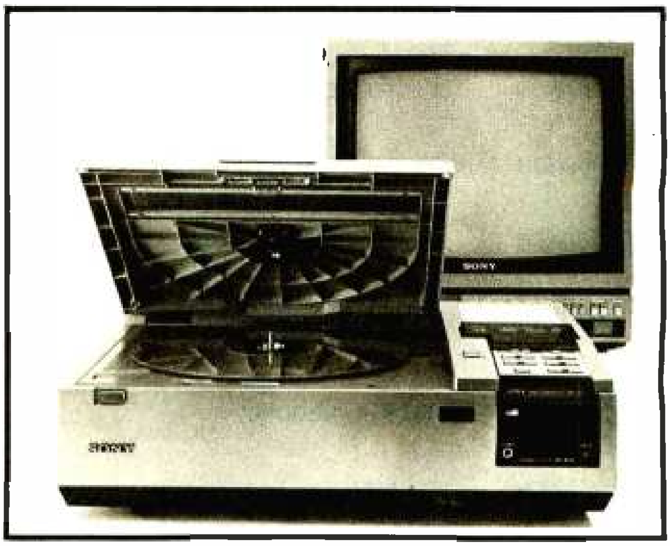


Photo 8: *The Sony LDP-1000 (level-two) optical reflective videodisc player, which has a built-in RS-232C interface.*

The Sony player also provides approximately 1023 bytes of initial memory, but there are a couple of differences. First, the idea of searching and autostopping is implied. The programming structure permits the user to program up to 63 "segments" on two pages, totaling 512 lines (0-255 and 256-511). The other difference is that each command does not consume one memory location. Following the previous example, this is how the LDP-1000 would store a simple program:

Bytes (Lines)	Command	Comment
1	Stop	Stop on . . .
2	S001	Segment 1
3	Play	Play to the end of . . .
4	S002	Segment 2

You would then define the length of each segment like this:

Bytes	Command
1	Segment 1 = 1-1000
2	Segment 2 = 1000-3000

Listings 1a and 1b: *Comparison between programs for the DVA PR-7820 and the Sony LDP-1000. Both programs perform the same function, but the Sony program is shorter because of its more efficient management of memory.*

1a

```
A DVA PROGRAM:

00  0
01  1
02  RECALL
03  2
04  STORE       SET 2 IN REG 1
05  1
06  2
07  8
08  5
09  6
10  SEARCH      QUESTION 1
11  5
12  INPUT
13  0
14  1
15  1
16  BRANCH      0. DEFAULTS 0
17  2
18  9
19  BRANCH      1. TO CORRECT ANSWER
20  3
21  6
22  BRANCH      2. TO REMEDIATION
23  3
24  6
25  BRANCH      3. TO REMEDIATION
26  3
27  6
28  BRANCH      4. TO REMEDIATION
29  STP FWD     CORRECT ANSWER
30  1
31  0
32  WAIT        WAIT 1 SECOND
33  5
34  0
35  BRANCH      TO MUSIC
36  6
37  8
38  0
39  1
40  SEARCH      REMEDIATION START
41  7
42  3
43  1
44  0
45  AUTOSTOP    REMEDIATION END
46  1
47  DEC REG     SUBTRACTS 1 FROM REG 1
48  5
49  BRANCH      TO QUESTION 1
50  1
51  2
52  8
53  7
54  0
55  SEARCH      MUSIC START
56  1
57  3
58  2
59  7
60  0
61  AUTOSTOP    MUSIC END (NEXT QUES)
62  HALT
```

1b

```
A SONY PROGRAM DESIGNED TO DO THE SAME THING:

SEGMENTS:
01  13016-13016
02  13017-13017
03  06931-07740
04  13032-13431

PROGRAM:
00  REG 0=     SET REGISTER
01  002
02  STOP
03  S001       QUESTION 1
04  000        WAIT INDEFINITELY
05  INPUT
06  1-016      1. (A) TO CORRECT ANSWER
07  2-010      2. (B) TO REMEDIATION
08  3-010      3. (C) TO REMEDIATION
09  4-010      4. (D) TO REMEDIATION
10  J=0        JUMP IN REGISTER 0
11  021        JUMP TO REMEDIATION
12  PLAY
13  S003       (PLAY WHEN REG 0=0)
14  GOTO
15  025        TO MUSIC
16  STOP
17  S002       CORRECT ANSWER
18  001        WAIT 1 SECOND
19  GOTO
20  025        TO MUSIC
21  PLAY
22  S003       REMEDIATION
23  GOTO
24  002        TO QUESTION 1
25  PLAY
26  S004       MUSIC SEGMENT (NEXT QUESTION)
27  END
```

Entering actual segment locations into memory does not affect the number of lines available for entering commands.

Listings 1a and 1b are more complex programs that exercise most of the programming capabilities of the DVA and Sony players. Assume that you have just seen a video sequence on the screen. The videodisc player is now waiting for you to input an answer to a multiple-choice question (four choices). You have two chances to make the correct choice. If you get the right answer, the program will step the disc player forward to a feedback frame, wait one second, play some music, and stop at the next question. If you get it wrong, the program will "search" and return you to the previous video sequence (remediation) to jog your memory, and then branch back to the same question. If you are wrong again, the disc will branch directly to the music and stop on the next question. From the listing, you can see that the Sony player is more economical with memory space than the DVA player.

Some problems exist, however, with using a bare-bones level-two system. First, you cannot just enter these

Photo 9: *The Discmaster 5000 by New Media Graphics, a complete level-three system using the Pioneer VP-1000 and an Atari 400 computer.*

programs into the players' memories and run them with any old videodisc. Significant frame locations, such as menus, questions, feedback frames, etc., must first be written and recorded onto video tape in an entirely separate environment (called postproduction or premastering). Once the significant frame locations, the program, and the video have been mastered onto a disc, it becomes a "video ROM (read-only memory)," which can cause another, more frustrating problem. If there is a bug in the program (e.g., the video player looks for the wrong frame number), the mistakes must be corrected by remastering the entire disc. DVA will provide a "proof" disc upon request so that programming can be verified prior to replication. You can also have your program simulated with a computer-controlled video-cassette or video-tape recorder (VTR) prior to mastering and replication, which seems to be a better solution (more on this later). Either way, producing an interactive videodisc is a "top-down" situation that can end up costing a lot of time and money if you are not careful.

The level-two videodisc players are faster than level-one systems, they are more rugged, and they provide better control capabilities for the user (because of the microprocessors). As stand-alone systems, however, they have some limitations.

Level Three

Level-three systems consist of either level-one or level-two videodisc players interfaced to a personal computer. Because there aren't any standards for videodisc players and due to the conflicting needs of videodisc producers and users, the interface can take many forms: those made exclusively for the Pioneer VP-1000; those designed to accommodate several disc players; interfaces made exclusively for Apple II, TRS-80, Atari, and custom-built computer systems; and generic interfaces made for any computer. Some interfaces are also designed to either switch (or "flip") back and forth from the computer's video output to the videodisc image or "key" the text/graphics from the computer directly onto NTSC video. Here are just a few examples of what's available.

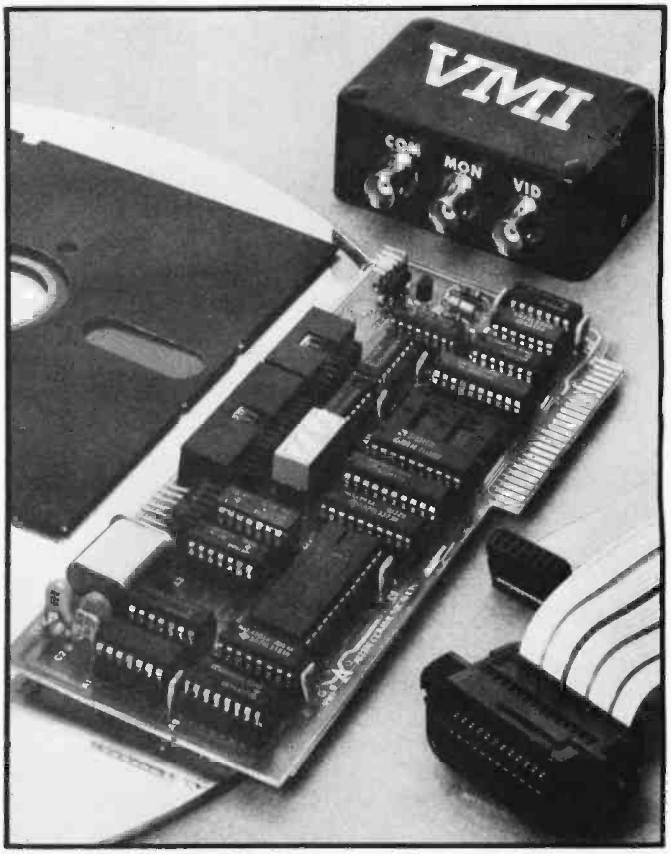


Photo 10: *The VMI by Allen Communication, an interface designed for the Apple II and almost every optical reflective videodisc player.*

Discmaster 5000 by New Media Graphics (see photo 9) is designed for the Pioneer VP-1000. This complete system includes an Atari 400 with 16K bytes of memory, Atari BASIC, floppy-disk drive, the New Media Graphics interface with a built-in Z80 processor (RS-232C serial), all necessary cables, connectors, user documentation, and the Pioneer VP-1000. Martin Duhms, its president, says, "New Media Graphics has now done the necessary system integration to deliver a ready-to-use system at a price comparable to what industrial videodisc players sell for by themselves. Also, the Discmaster 5000 allows complete reprogramming in BASIC of the videodisc playback, which the other players don't." New Media Graphics also offers the Discmaster 1000, which is similar to the Discmaster 5000 minus the Atari 400 and the Pioneer VP-1000. New Media Graphics, 139 Main St., Cambridge, MA 02142, (617) 547-4344.

Another system for the Pioneer VP-1000 is the Omniscan by Aurora Systems Inc., which uses an Apple II as the exclusive controller. The Apple duplicates the operation of the Pioneer VP-1000's keypad and automatically "flips" the video between the computer's output and standard video. The Omniscan includes the interface, documentation, and a tutorial on the software (the Apple II and Pioneer VP-1000 are extra). Aurora Systems Inc., 2040 East Washington Ave., Madison, WI 53704, (608) 249-5879.

The VMI by Allen Communication (see photo 10) is

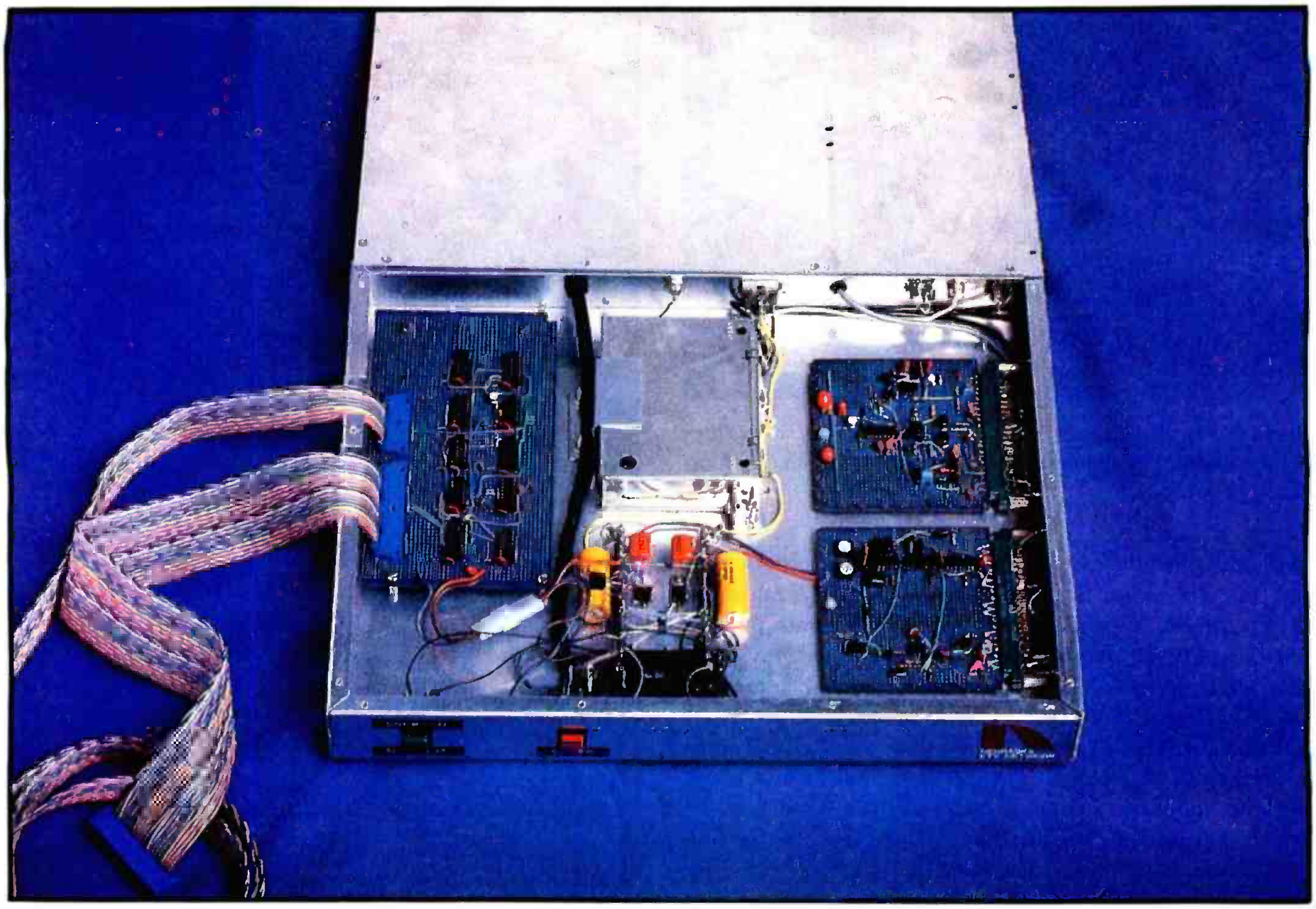


Photo 11: *The first-generation "wire-wrapped" model of the "overlay" interface for the TRS-80 Model I, by the Videodisc Design/Production Group. The second-generation unit (not shown) is designed as a "plug-in" inside the TRS-80 Model III and uses the Model III's RS-232C port.*

also designed exclusively for an Apple II, but it can drive every existing optical videodisc player with the exception of the Magnavox 8000. The VMI includes an extremely well-documented user's manual, the interface, switching box, cables, software, information packet, and a sample videodisc. Allen Communication, 3004 Arapahoe Ave., Boulder, CO 80303, (303) 449-2971.

Some systems are based on a company's own personal computer, such as the Positron system by Ron Lane. This is a hardware and software system that arranges interactive strategies hierarchically. Still frames, motion, and text can be selected from five types of displays: (1) outline, in any level of detail; (2) dictionary; (3) questions; (4) titles that relate to a particular frame; and (5) titles previously selected. The nice thing about the Positron system is that its application to program development requires no computer programming or storyboarding of the video, which are two of the main bottlenecks in interactive videodisc production. Information need only be listed; Positron controls everything else, including the interaction. The Positron system comes with its own specially built microcomputer (64K bytes of memory), disk drive, special keyboard, interface, software, and operating system (the Pioneer VP-1000 is extra). Ron Lane, Positron, 30 Lincoln Plaza, Suite 3S, New York, NY 10023, (212) 586-1666.

Another such system is the Random Access Video Controller (RAVC), supported by a 68000-based microcomputer, developed by Wicat Systems. The RAVC uses the TI 9900 microprocessor for on-board intelligence with 16K bytes of video RAM. It works with any available commercial optical videodisc player, including the Magnavox 8000 if some modifications are made to the player. The controller has both serial and parallel ports for interfacing to the videodisc player. In addition to player control, the RAVC also has a TI 9981 video-processor chip (the same chip as in the TI 99/4 home computer) that provides it with its own video-display capabilities. It can generate screens with 16 different background colors and 16 character colors. Like the 99/4, the controller board can create different video planes for animation. Wicat Systems, 1875 South State St., POB 539, Orem, UT 84057, (801) 224-6400.

Another type of interface falls into the category of "video reprocessing." This, very simply, is the process of converting the video from the computer to mix with the 525-line NTSC standard television.

Sanders Associates has developed a video-reprocessing system made for an Apple II, called the Interactive Video Training System (ITVS). Besides being able to mix Apple-generated text and graphics with NTSC video, the ITVS can also carry digital data "nested" unseen in the NTSC video signal. This data can be used to define the location of an object, download instructions to the computer on the rules and procedures needed for a given sequence, overlay Apple/NTSC text and graphics symbols on the video picture, and control the functions of the VTR or videodisc player. Sanders Associates Inc., 95 Canal St., Nashua, NH 03060, (603) 885-3731.

Another video-reprocessing system designed for the Apple II is available from Video Associates Labs Inc. The VB-3 Micro-Keyer allows the Apple II to be used for both video production and training. It comes with software that allows a person with no technical knowledge of video or computers to take full advantage of the broadcast features built into the VB-3 Micro-Keyer system. Video Associates Labs Inc., 2304 Hancock Dr., Suite 1-F, Austin, TX 78756, (512) 459-5684.

This type of system is marketed primarily to television stations. For example, they use it to key weather maps, forecasts, etc., directly onto the screen during news programs. While they are considered real bargains compared to the cost of the other broadcast equipment, unfortunately, most video-reprocessing systems cost more than the personal computer that controls them.

The Videodisc Design/Production Group

In April 1980, the Nebraska Videodisc Design/Production Group demonstrated the first version of the overlay interface (see photo 11). Like other video-reprocessing systems, this configuration is also a true keyer. But being able to key is merely the end result. "Interlace" is accomplished prior to keying. The overlay interface is designed exclusively for the TRS-80 Models I and III. Focusing on the TRS-80 enabled us to build the keyer minus expensive signal processing, making the system affordable to the personal computer user at home, at school, or on the job. While the overlay contains a decoder for turning the video on and off, it also permits interaction between text/graphics generated by the computer and television images, which is preferable in our book to merely switching back and forth from computer to videodisc.

The utility software package designed to control our level-three discs is called the VDC-1 (videodisc controller). The package, written in Z80 assembly language, is designed to be called from disk BASIC, although it is possible to call it directly from assembly language, or even from FORTRAN or some other high-level language. A common subset of disc player functions is provided, and it is possible to extend the capabilities of the package by adding custom functions. It is also possible to download or perform data dumps to players that have internal intelligence (e.g., DVA PR-7820 and the Sony LDP-1000). Macros are also allowed, making it possible for the programmer to send a string of commands that are frequently used or requested, thus saving time and memory.

Some of the internal (housekeeping) functions include initialization, a manual mode, player-definition mode, and frame lock-out. Initialization consists of telling the VDC-1 which player is connected to the TRS-80. The VDC-1 asks the user which videodisc player is being used and then performs all functions transparently. For example, if your BASIC program was written using the DVA PR-7820 as a development system, the program could run in the field with a Pioneer VP-1000. The VDC-1 is designed for that kind of compatibility.

In addition to the standard keyboard functions that can be accessed manually, the VDC-1 supports the decoding functions of the overlay with video on/video off commands so that the computer can continue to display information while the player searches to a location. This is particularly applicable for the Pioneer player (worst-case access: 18-20 seconds). Other commands include lock-out functions for both frame locations and the player panel, timing and pause commands for CLV discs, and "bookmark" commands that switch from computer control to manual control and resume again where the user had previously left off.

Videodisc Production

Designing and producing an interactive videodisc is similar to writing, producing, and directing a film. Hidden in both the film and disc development are layers of various media (including computer software) and hours of evaluation in many forms. What really sets interactive videodisc development apart from the development of motion pictures or television productions, however, is interactivity, the dynamic interplay between the user and the medium—which neither film nor television can provide. Yet, as we have learned something about developing interactive discs, as producers, we have also learned that we are using yesterday's tools to develop tomorrow's media. [**Editor's Note:** *To give you a better understanding of the various steps involved in the production of an interactive videodisc, we have included a design and production chart on pages 56 and 57. . . .***S. J. W.**]

Our pet project (and pipe dream) for the last two years has been the development of an interactive editing system (IES), which could individualize the postproduction process in the same way that filmmaking is individualized during the editing process. The requirements for an IES as we see them include read-write capability, rapid-frame access, broadcast quality, the ability to reedit, simulation capabilities, and portability. The IES would be a computer-controlled offline system. Under ideal circumstances, the computer would be involved from the design process, flowcharting, creating visuals, etc., right up to the final coding of the finished product.

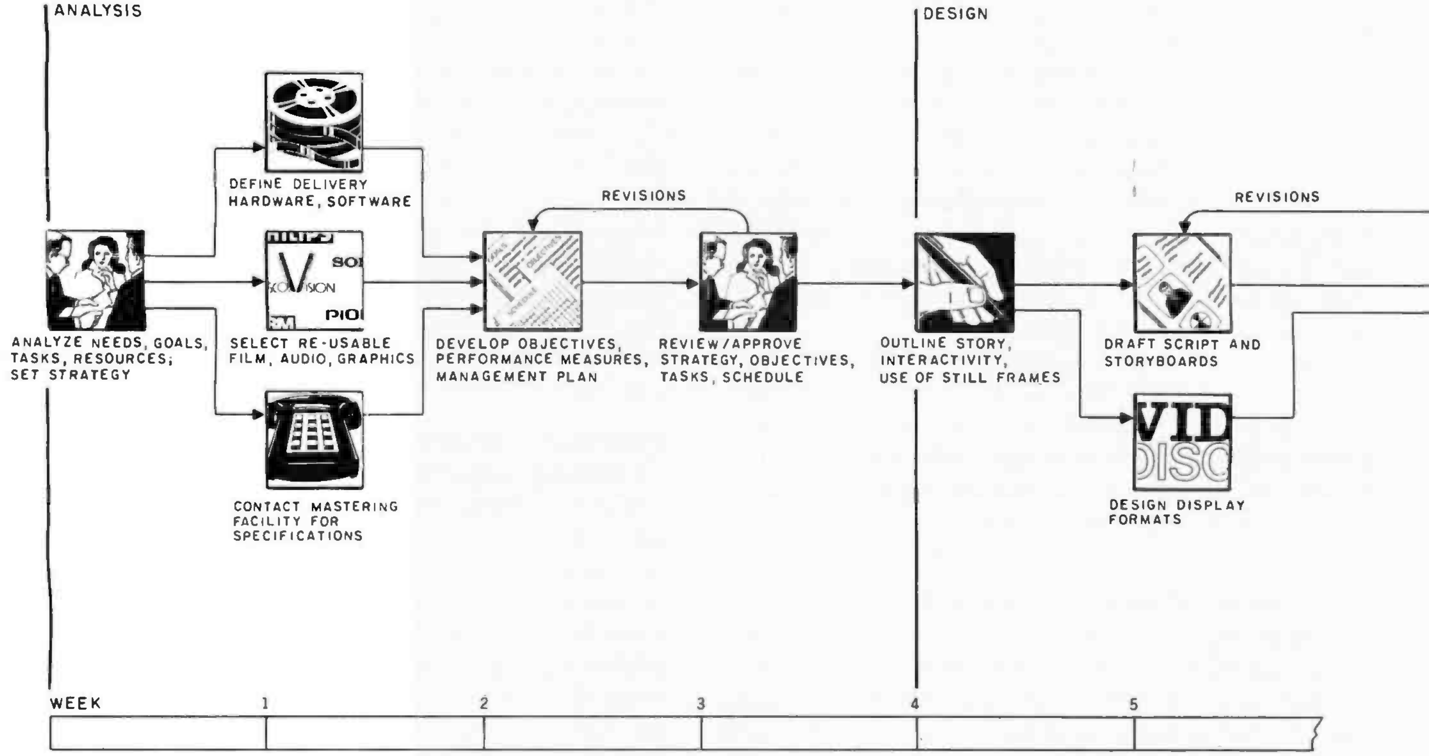
The first signs of an IES are beginning to appear. We are blessed with a first-rate teleproduction facility, and as we move further into the digital world, we are able to piece things together.

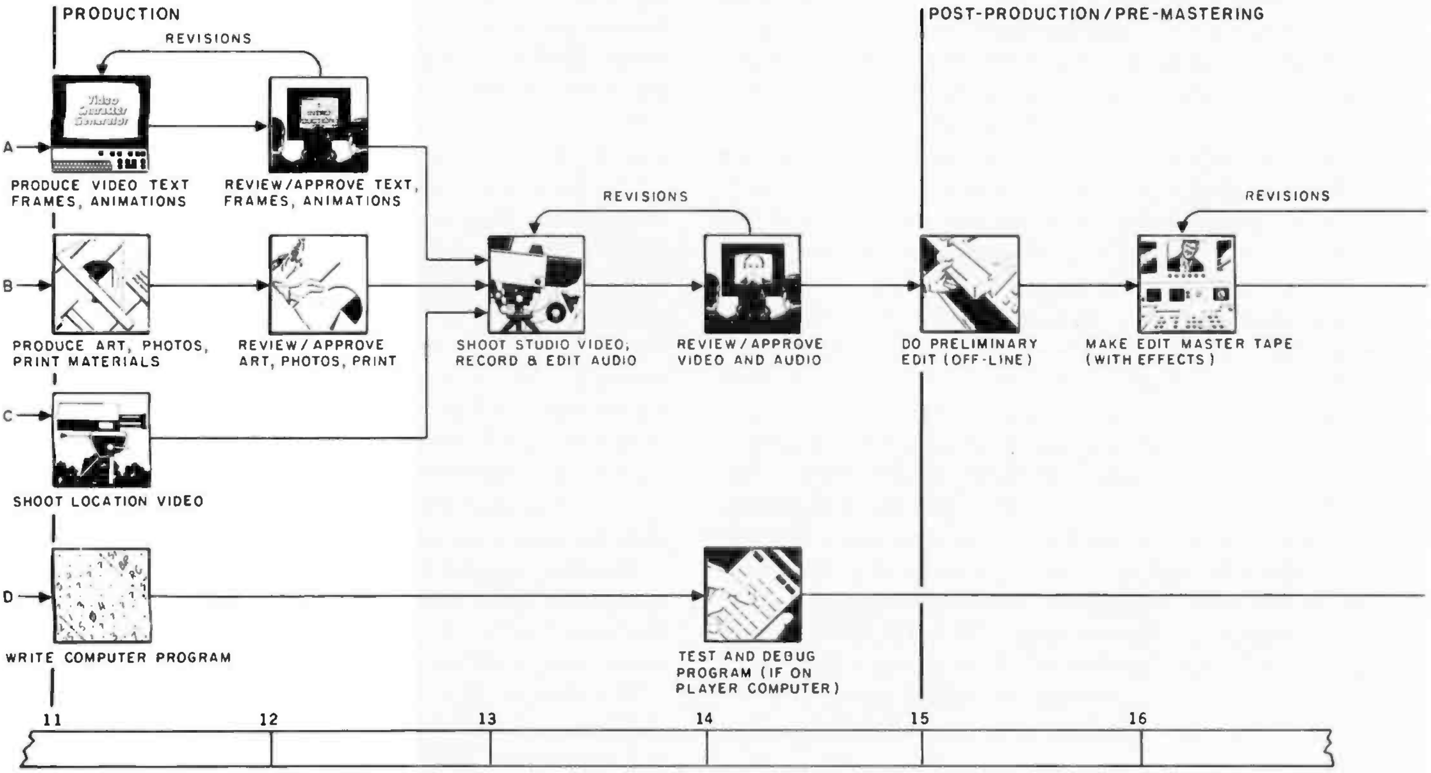
The current IES configuration is based on a Bosch BCN-50, a 1-inch helical VTR, controlled by an 8080 microprocessor with an RS-232C serial interface, de-

Text continued on page 58

Interactive Videodisc

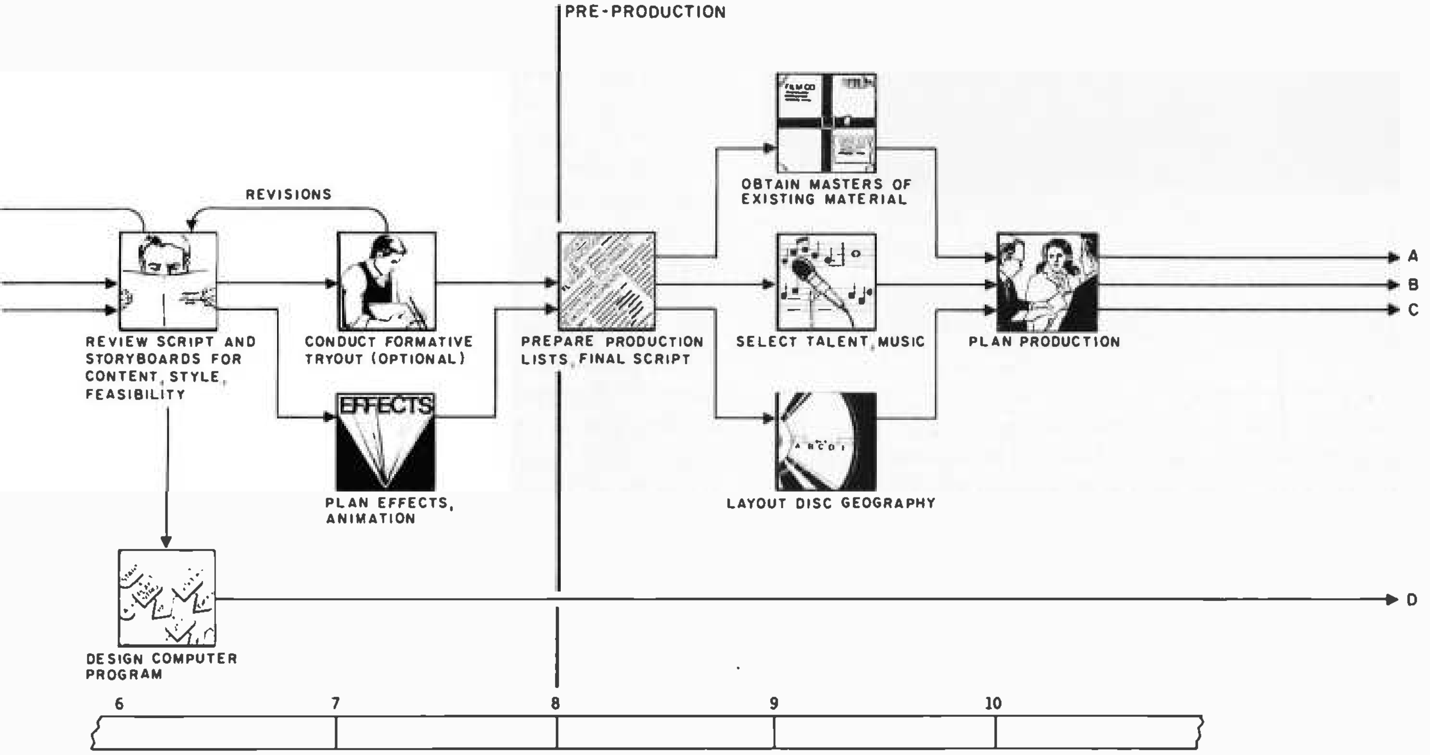
The design and production chart shows the steps required to design, develop, and produce an interactive videodisc. The individual steps vary in length and complexity. Although some activities may overlap in practice, each step in the sequence depends on the successful completion ot the steps leading up to it. A critical stage occurs at the beginning, when the client and subject-matter experts define the goals and objectives for the videodisc program. The participation of the client is also essential at every "review/approve" step (marked by a "revision" path back to the previous step).





Design and Production

The schedule shown here—20 weeks from concept to master tape—suggests the time typically recommended for a well-managed project of medium complexity, using primarily studio production (with one or two scenes shot on location), about 400 still frames, and a modest computer program. Simpler projects require less time, while those employing sophisticated computer-simulation techniques take longer, both to produce and to plan. For videodiscs controlled by an external computer system, program coding and testing can continue during the mastering of the videodiscs.



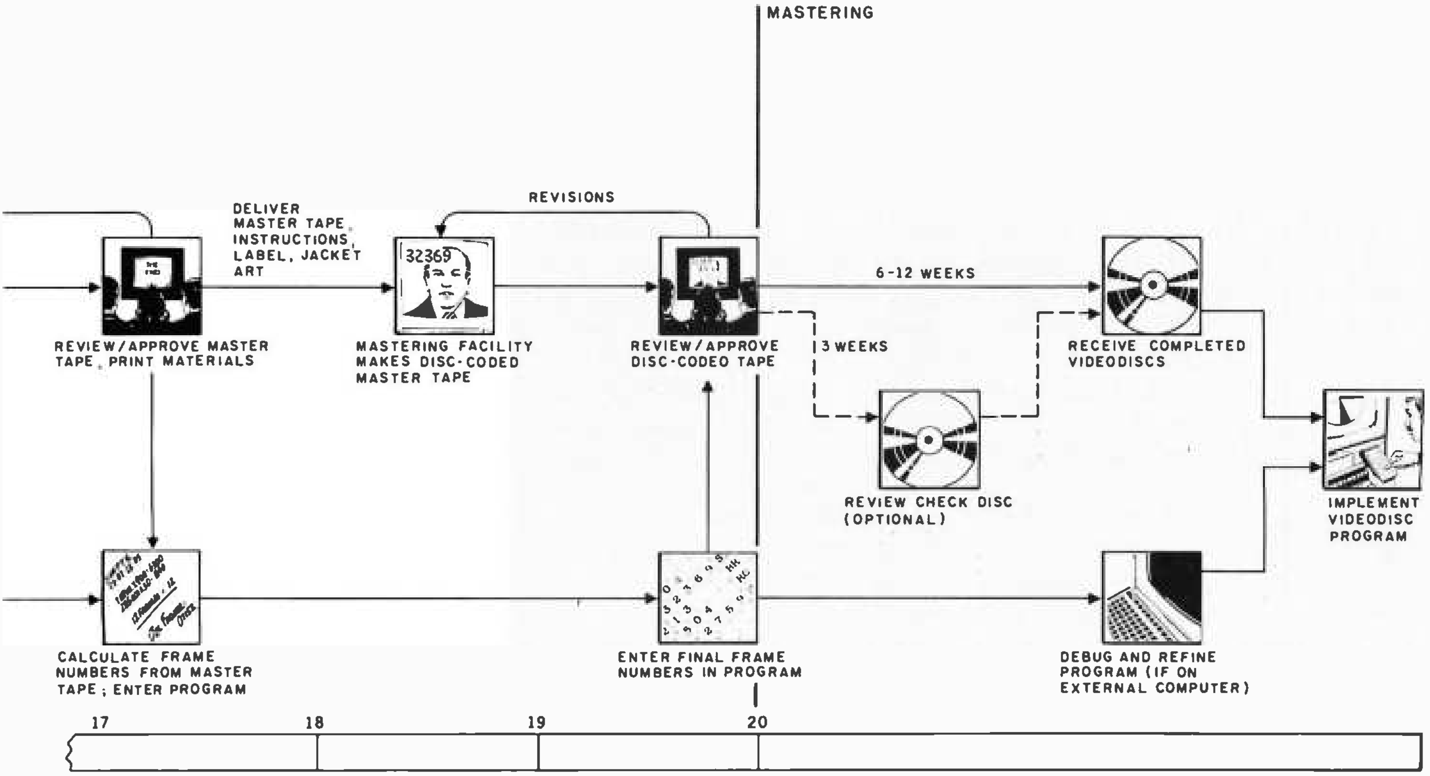


Photo 12: *A videodisc simulator/editor developed by the Videodisc Design/Production Group. The Bosch BCN-50 1-inch helical VTR (left) serves as a surrogate disc player but with the added capability of offline insert edit capability with "broadcast quality."*

Text continued from page 55

signed and built by our group (see photo 12). Using this standard interface, the BCN-50 can be driven by almost any external source. The 8080 system already had programming in EPROMs to control the tape transport and still store functions. The main task was to locate and control the subroutines stored in the EPROMs and write a "driver" program to access and execute them in a manner that would duplicate the capabilities of a videodisc player. Once the driver was completed, software was developed that recognized inputs from any given disc player. From there, the user-oriented software could be written.

Since the Bosch machine is a broadcast-quality recorder with full editing capabilities, it operates by the same SMPTE time code used to assemble materials online. Also, since it is a recorder with frame-accurate editing capability, part of the tape can be edited offline to revise a text frame or menu, for example.

Once the premastering stage has been completed and a finished tape is available, the master can be made. The coded tape is sent to a mastering facility, where a master is made on a glass disc. This master is then used to produce the finished videodisc.

Into the Future

The videodisc has almost unlimited potential. Programs will appear that are made for interactive use, including games, educational programs, simulations, and more. The future of interactive videodisc technology could be as bright as the microcomputer industry itself, and the videodisc may become the medium of the eighties. ■

Glossary

(This information can also be found in 3M's Producing Interactive Videodiscs *manual.)*

authoring: *a structured approach to developing all elements of an interactive videodisc program with emphasis on preproduction.*

branch: *an instruction to diverge from one sequence in a program to another.*

capacitance disc: *a videodisc system that uses capacitance signals embedded on the disc and a stylus that touches the surface of the disc to read encoded information.*

CED: *capacitance electronic disc developed by RCA.*

chapter: *a consecutive sequence of frames.*

chapter stop: *a code embedded in the vertical interval of the videodisc that enables certain videodisc players (mostly level one) to locate the beginning of chapters.*

compressed audio: *sometimes called still frame audio, compressed audio describes a method of digitally encoding and decoding several seconds of voice-quality audio per individual disc frame, resulting in a potential for several hours of audio per disc.*

constant angular velocity (CAV): *a CAV disc revolves continuously at 1800 rpm, one revolution per frame, making each frame of a CAV disc addressable, a basic requirement for interactive videodiscs.*

constant linear velocity (CLV): *a CLV or extended-play disc maintains a consistent length for each frame, thus enabling longer playing time per side, but sacrificing individuul frame addressability. Reference to locations on CLV discs is limited to time in minutes and seconds. CLV discs are basically useless for interactive videodisc applications.*

cue: *a pulse entered onto one of the lines in the vertical-blanking interval (VBI) that results in frame numbers, picture codes, chapter codes, closed captions, white flags, etc., on the disc.*

direct-read-after-write (DRAW): *a record-once optical-disc technology primarily used for mass storage of digital data.*

field: *a scan of 262 lines on the screen at 1/60 second constituting one-half of a complete video frame. See* **frame**.

flicker: *sometimes known as "interfield jitter" or "jitter," flicker is a phenomenon that occurs in a videodisc freeze frame or still frame when both fields are not identically matched, thus creating two different pictures alternating every 1/60 second.*

frame: *two complete scans of the video screen at 1/30 second. A frame is composed of two fields (at*

262 lines) and a retrace; a single frame is a standard CAV videodisc reference point. There can be as many as 54,000 addressable frames on one side of a CAV videodisc.

freeze frame: *a single frame from a motion sequence that is stopped.*

full frame time code: *otherwise known as nondrop frame time code, full frame time code is a standardized SMPTE (Society of Motion Picture and Television Engineers) method of address-coding a video tape. It gives an accurate frame count rather than an accurate clock time.*

interaction: *a reciprocal dialogue between the user and the system, interactivity.*

interchangeability: *a videodisc design strategy that includes information readable on consumer, industrial, and computer-controlled videodisc systems.*

interlace: *in NTSC video, half the horizontal scanning lines are laid down. After retrace, the other half are laid down so that they fall in between the previous lines.*

intermediate materials: *all media selected for assembly onto the videodisc premaster (i.e., 16mm film, video tape, 35mm slides, etc.).*

jaggies: *a tearing phenomenon around the edges of NTSC images. Research at MIT has effectively solved this problem. By so doing, it has created a new way of thinking about displays, computer graphics, and NTSC video. See* **soft fonts**.

keyer: *it cuts a hole in the background video and fills in the hole from a different video source, i.e., computer-generated text and graphics keyed over NTSC video. See* **video reprocessing; overlay**.

landing pad: *a range of frames within which a player can locate a frame or frame sequence. Landing pad (LPD) is also a command that modifies the number of times a player attempts to locate a frame following an unsuccessful search.*

level of interactivity: *the potential for interaction prescribed by the capabilities of videodisc hardware.*

level one: *usually a consumer-model videodisc player with still/freeze frame, picture stop, chapter stop, frame addressability, and dual-channel audio, but with limited memory and less processing power.*

level two: *an industrial-model videodisc player with the capabilities of level one, plus on-board programmable memory and improved access times.*

level three: *level-one or level-two players interfaced to an external computer.*

level four: *a theoretical configuration with more advanced equipment wherein all things are possible.*

mastering: *a real-time process in which the premaster video tape is used to modulate a laser beam onto a photosensitive glass master disc.*

NTSC: *the American television standard set at 525 lines by the National Television Standards Committee.*

optical disc: *a videodisc that uses a light beam to read information from the surface of the disc.*

optical memory: *digital data encoded on an optical disc used for mass data storage. It is estimated that one side of an optical disc could store up to 10 billion bits.*

overlay: *a term used to describe the keying of computer-generated text/graphics onto NTSC video.*

picture stop: *an instruction encoded in the vertical interval on the videodisc to stop the videodisc player on a predetermined frame.*

postproduction premastering: *sometimes called video processing, this is the process of editing, assembly, evaluation, revision, and coding of intermediate materials. A premaster is a fully coded video tape.*

preproduction: *all design tasks, e.g., flowcharting, storyboarding, scriptwriting, software design, etc., prior to videodisc production.*

reflective (optical) disc: *method by which the laser beam reads data encoded on an optical videodisc. In the case of a reflective disc, the laser beam is reflected off the shiny surface on the disc.*

scan: *to traverse the surface of the disc with the video displayed.*

search: *to rapidly access a single frame or a sequence of frames on a disc with video off.*

sequence: *two or more frames forming one unit, e.g., motion sequence, still-frame sequence.*

slow motion: *in videodisc technology, the controlled movement of the laser from frame to frame at a variable rate of less than 30 frames per second.*

soft fonts: *a gray-level scheme developed by MIT for high-quality fonts in NTSC video. This adds legibility, removes scintillation, and enhances encodability, which results in a display with more than 80 characters per line on a color-television receiver.*

step: *to advance one frame forward or reverse.*

still frame: *still material, including photographs, line drawings, pages, etc., designed and presented as a single videodisc frame.*

three-two (3-2) pulldown: *a means of transferring film shot at 24 frames per second (fps) into video (30 fps). The first film frame is actually exposed on three video fields, and the next film frame is exposed on two fields.*

transmissive disc: *method by which the laser beam reads data encoded on an optical videodisc. In the case of the transmissive disc, the laser beam passes through the transparent surface of the disc.*

vertical-blanking interval (VBI): *21 blanked lines during field 1 and 21 blanked lines during field 2, wherein frame numbers, picture stops, chapter stops, white flags, closed captions, etc., are encoded.*

VHD: *video high density (see* **capacitance disc***).*

video reprocessing: *the process of keying video from the computer over NTSC video.*

white flag: *a code that identifies a new film frame.*

Ciarcia's Circuit Cellar

Build an Interactive-Videodisc Controller

You can use your personal computer to control a Pioneer VP-1000 laser-optical videodisc player through its remote-control circuitry.

Steve Ciarcia
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Glastonbury, CT 06033

The theme of this issue is computers and videodiscs, so I don't need to explain why I chose this month's Circuit Cellar project. Several articles this month make specific reference to the capabilities of a video presentation directly controlled by a computer.

With that in mind, my objective is to discuss the more familiar consumer videodisc players and outline how you can build an interface for your computer that allows it to control a Pioneer VP-1000 Laserdisc player. The required hardware is as involved as you care to make it. The software experts among you might in fact be able to do the trick without any special hardware.

Perhaps by experimenting with a videodisc you will more easily recognize the potential benefits of this revolutionary data-storage medium. First, we'll look at the way information is stored on the disc, and then we'll examine how to build an interface to a personal computer.

It's really rather simple to design and use a full-function computer/videodisc-player interface.

Videodisc Information Storage

About the size of a 33⅓-rpm long-playing phonograph record, a videodisc contains not only audio (sound) information but video (picture) information as well. Because the basic function of videodisc equipment has been to play back programming such as motion pictures and special-purpose television shows (although, as I alluded, the videodisc can serve other purposes), the disc was designed to store this kind of normal, TV-type programming.

For such programming, the amount of data needed to store the video portion is vastly greater than that needed for the audio portion: the video bandwidth is much greater, so it is impossible to use the recording method used for conventional audio discs, a continuous surface groove cut so that the amplitude of the transverse linear excursions of a stylus tracing the groove corresponds to the amplitude of the signal.

Diligent engineers have thus far developed two widely used, competing methods of storing video data on a disc: the capacitive method and the optical method. Several manufacturers have developed variations of each

Photo 1: *The Pioneer VP-1000 Laserdisc optical videodisc player. The unit in this project has both wire and wireless remote-control inputs; some other players may not have both of these. The principles in the project can be adapted to other videodisc players with similar characteristics.*

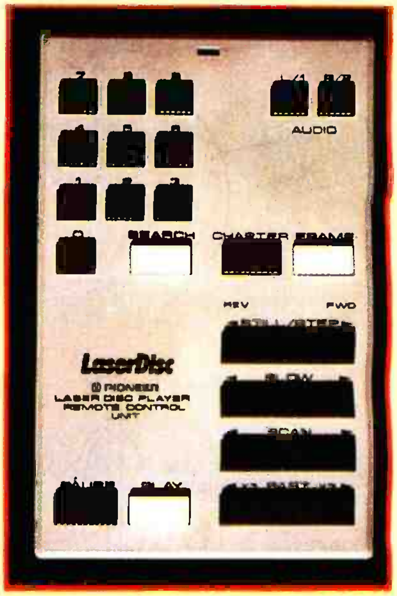


Photo 2: *The hand-held remote-control unit for the VP-1000. All of the functions work only in the standard-play mode, but not in the extended-play mode.*

technique, but a discussion of the systems as used in only two products will suffice for illustration.

Capacitance-Encoded Discs

Videodisc players from RCA use a capacitance encoding system named Capacitance Electronic Disc (CED). A CED disc contains a spiral surface groove, as does an audio disc, in which a metal-coated diamond stylus rides in physical contact with the rotating disc. There are approximately 10,000 groove layers per radial inch, producing a 1-hour playing time per side. The groove is about 1/38 the width of the groove in an audio disc.

The video and audio signals are en-

JPL Puts the Planets on a Disc

The Jet Propulsion Laboratory (JPL) of the National Aeronautics and Space Administration (NASA) is preparing a videodisc for distribution to various geology schools, planetary-geology laboratories, and some libraries. The disc contains some 100,000 planetary images collected by space probes, including the Mariner, Viking, and Voyager missions.

Viewing this disc, you can see what the space probes saw as they crashed into Mars, plunged past Venus and Mercury, and swooped past Jupiter and its moons.

Each frame on the videodisc contains one black-and-white still image, with the images stored, for the most part, in the order they were taken. A test videodisc prepared earlier contained some full-color images, but the final research version is all monochrome. (A very clever video technician could reconstruct a few full-color images by electronically combining some of the three-frame sets of the same field of view shot through three subtractive-primary color filters.)

Working under contract to JPL, the Sony Corporation developed for this project a special method for encoding the laser-optical videodisc so that the same disc can be played with full still-frame capability by Pioneer, Sony, MCA, Philips, and DVA (Discovision Associates) videodisc players. (Ironically, it now seems that several of these companies will discontinue production of videodisc players.)

Last February at the San Francisco Video Expo trade show, Mike Martin, Planetary Data Management Team Leader for JPL's Planetary Image Facility, demonstrated a planet-image search-and-retrieval system. He used a Sony videodisc player, controlled by an Apple II equipped with a joystick and a control program written in BASIC, to show attendees how to take an imaginary tour of a planet's surface, using the joystick as a "throttle" to speed up or slow down the displaying of images from the videodisc. He reports that the people who used the system quickly became enthusiastic about the capabilities of the system and the technology that makes it so easy to widely distribute pictures of the planets.

*But at present NASA has no plans to make discs available to the public, though there are plans to produce a second research disc containing the remainder of NASA's space-picture archive, including Voyager's pictures of Saturn....***R.S.S.**

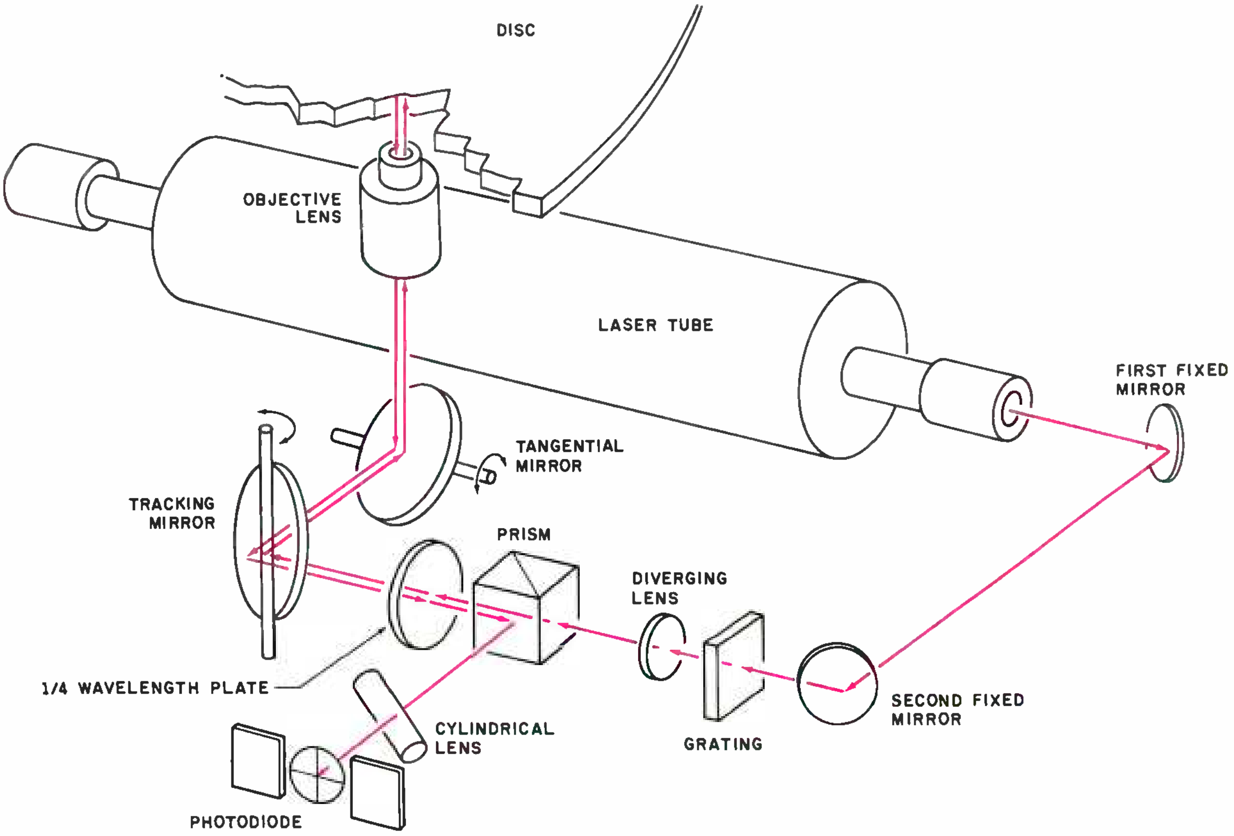


Figure 1: *Diagram of the path of the laser light beam inside the Pioneer VP-1000 Laserdisc videodisc player. The red helium-neon laser projects its light though a complex optical path to the information-bearing layer of the videodisc. The light is reflected into the photodiode in a pattern that reproduces the carrier signal for the program material.*

coded by frequency modulation on a carrier signal that is represented on the disc by the presence or absence of pits in the groove. The metal coating on the stylus functions as one plate of a variable capacitor. The disc itself, which is made of conductive vinyl, forms the other plate. As the stylus moves along the groove, the presence and absence of pits generates a variable capacitance which is converted to a voltage that reproduces the carrier signal.

Each "track" (a single rotation of the disc) in the CED system contains four video frames. Such high density allows lengthy recordings of one hour per side but prohibits slow motion and still-frame viewing. Therefore, RCA and other CED-system players are not well suited to certain computer-controlled applications. Also, because CED-system videodiscs use a contact interaction with the playback mechanism, they are sensitive to scratches and debris that can collect on the disc surface; you have to take care to keep them unmarred and clean.

Optical-Encoded Discs

The Pioneer VP-1000 Laserdisc system uses the optical-reflective videodisc encoding method jointly developed by MCA and Philips. The VP-1000 uses a disc in which the carrier signal is stored as an alternating spiral series of reflective areas and opaque pits in a layer lying underneath a surface that is smooth, grooveless, and transparent.

Figure 1 is a diagram of the optical scanning system inside the Pioneer Laserdisc player. The visible-red light beam from a low-power helium-neon laser is directed through a series of lenses and mirrors to the disc. The light shines through the surface layer and is reflected off the information-bearing layer back through the surface and optical path onto a photodiode. When the incident light hits an opaque pit, it is not reflected back. The photodiode detects the presence or absence of reflected light and converts it into a current that reproduces the recorded carrier signal, on which the video and audio signals are modulated.

The Pioneer player can play back a videodisc at two different rates: standard play and extended play. The two modes are distinguished by differences in the density of the recorded data and the speed of the drive mechanism. In the standard-play mode, the information is stored on the disc so that the system reads data at a constant angular velocity (CAV), whereas in the extended-play mode, the data is read at a constant linear velocity (CLV—constant along the path traversed by the laser beam).

In addition to these differences from the CED system, the optical videodiscs used by the Pioneer machine have the advantage of near immunity to wear and tear. Because the video information is sandwiched between protective transparent plastic layers, the disc is undamaged by dust and scratches. The laser just looks through the surface junk to the information-bearing layer beneath. Also, because the disc player has no stylus and uses a noncontact readout method, there is absolutely no wear on either the disc or the photodiode when in use, even in the still-frame mode, although some motion occurs in the optical-tracking mechanism.

Two Operating Modes

In the VP-1000's CAV mode, the disc always rotates at 1800 rpm (revolutions per minute), so that one rotation takes 1/30 of a second. A single video frame (one still picture) is recorded on each rotation (track) of the disc; each side of the disc contains 54,000 tracks and therefore 54,000 frames. At the center of the disc, the packing density (amount of data squeezed into a given segment of a track) is four times greater than on the outside edge.

Because each rotation plays only one frame, it is possible to view a single frame as a still picture by causing the laser beam to repeatedly scan the same track. Because of the single-frame-per-track arrangement of data and the constant disc speed, the scanning repetition occurs 30 times per second, which is the standard television frame-refresh rate (in North America), and there is no flicker or distortion of the picture. This still-frame capability is unique to the optical videodisc players; it facilitates fixed- and variable-speed slow motion, fast motion, and rapid scan in both forward and reverse. Features such as these are very important in educational and industrial applications where viewers might want to stop and discuss pertinent details of various still pictures.

While the CAV mode is particularly suited for video interaction and computer-related activities, the extended-play CLV mode was designed simply to store more video frames, to be competitive with CED-format video players in the length of the program that the disc can hold. It would be impractical and cost-prohibitive to require three discs for an average-length movie.

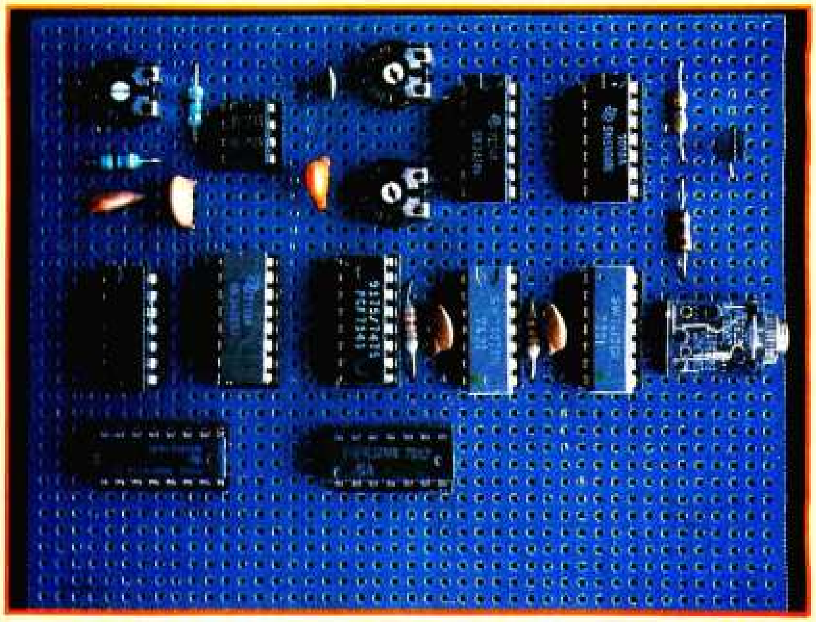


Photo 3: *Prototype of the hardware-intensive interface circuit of figure 3. These components simulate the remote-control unit, generating pulse-code-modulated control codes under software control.*

In the CLV mode, the track closest to the center of the disc contains one frame, while a track on the outside edge contains four frames. The packing density of the information is the same for all frames. By varying the speed of rotation from 1800 rpm (when the light beam is reading from the center of the disc) to 600 rpm (when reading at the edge), up to one hour of program material can be recorded on each side. Unfortunately, because more than one frame is stored per track, various special functions such as still-frame, slow motion, and fast motion are inhibited. Since the projected applications of my videodisc interface need these features, I shall discuss the use of only the standard-play discs and the CAV mode.

Embedded Signals

So far we have seen that the VP-1000 is indeed an advanced videodisc player for use in entertainment. More significant to us, however, is that the VP-1000 is directly suited for remote control through a computer.

Various control codes and data are placed in the video signal, in the vertical-blanking interval that occurs between the fields of picture information. (The vertical-blanking interval can be seen as the black horizontal bar across the screen when you cause the picture on your TV screen to roll vertically.) The VP-1000 stores 24-bit biphase-coded signals that define picture numbers, picture stops, "chapter" numbers, and various control codes (CAV-mode, CLV-mode, lead-in, and lead-out).

Every still picture on a CAV videodisc has a unique frame number (from 1 to 54,000). Using this number, the player-control system can identify and search for any one of the 54,000 frames and display it. This ability to so easily recall 54,000 separate still pictures may revolutionize certain types of visual research, when coupled with a computer-control system. (See the text box "JPL Puts the Planets on a Disc" on page 61.)

To search for and view one of these 54,000 frames, you merely enter the frame number on the VP-1000's control keyboard. The microprocessor control system in the player then searches for that particular frame and displays it on the video screen. The slowest access time is about 20 seconds; for 2 frames within 1000 counts of each other, it takes about 5 seconds.

VP-1000 Remote Control

In reading magazine articles about videodiscs, I've seen many descriptions of videodisc formats and reviews of various commercial interfaces to the VP-1000, but I've seen very few articles that actually discuss the construction of an interface to the VP-1000 and disclose the control codes needed. (I did read one in which the author cut the Gordian knot: he unsoldered the encoder chip from the Pioneer hand-held remote-control keyboard and reattached the chip to a parallel port on a Commodore PET computer.)

It's really rather simple to design and use a full-function computer/videodisc-player interface without resorting to destructive measures. In the version of the Pioneer VP-1000 Laserdisc machine that I have, the optional remote-control keyboard communicates with the main unit by coded signals sent through a cable or via a wireless infrared-light link. These coded signals can easily be created by an external computer connected through the VP-1000's remote-control input jack. (Or use an infrared link similar to the one I described in "Use Infrared Communication for Remote Control," April 1982 BYTE, page 40.)

Control Encoding

The VP-1000 can recognize and act on 25 different commands (listed in table 1) that are transmitted via a 10-bit PCM (pulse-code modulation) scheme. In the code combinations, five of the bit values are fixed, and five vary to specify the command. The first three bits (K0, K1, and K2) always have the values 0, 0, and 1, respectively. Similarly, the last two bits (D5 and D6) are always 0. Bits D0 through D4 form the command-selection segment of the transmission. For example, to command the player to pause, the remote-control unit sends the 10-bit code 0010101000, in

Function	Signal Transmission Code Value									
	K0	K1	K2	D0	D1	D2	D3	D4	D5	D6
0	0	0	1	0	0	0	0	1	0	0
1	0	0	1	1	0	0	0	1	0	0
2	0	0	1	0	1	0	0	1	0	0
3	0	0	1	1	1	0	0	1	0	0
4	0	0	1	0	0	1	0	1	0	0
5	0	0	1	1	0	1	0	1	0	0
6	0	0	1	0	1	1	0	1	0	0
7	0	0	1	1	1	1	0	1	0	0
8	0	0	1	0	0	0	1	1	0	0
9	0	0	1	1	0	0	1	1	0	0
Search	0	0	1	1	1	0	1	0	0	0
Chapter	0	0	1	0	0	1	1	0	0	0
Frame	0	0	1	0	1	0	1	1	0	0
Audio L/1	0	0	1	0	1	1	1	0	0	0
Audio R/2	0	0	1	1	0	1	1	0	0	0
Still/Step										
Forward	0	0	1	0	0	1	0	0	0	0
Reverse	0	0	1	1	0	0	1	0	0	0
Scan										
Forward	0	0	1	0	1	0	0	0	0	0
Reverse	0	0	1	1	1	1	0	0	0	0
Fast										
Forward	0	0	1	1	0	0	0	0	0	0
Reverse	0	0	1	0	1	1	0	0	0	0
Slow										
Forward	0	0	1	1	1	0	0	0	0	0
Reverse	0	0	1	0	0	0	1	0	0	0
Mode										
Pause	0	0	1	0	1	0	1	0	0	0
Play	0	0	1	1	0	1	0	0	0	0

Table 1: *The 25 control codes accepted by the Pioneer VP-1000 Laserdisc player.*

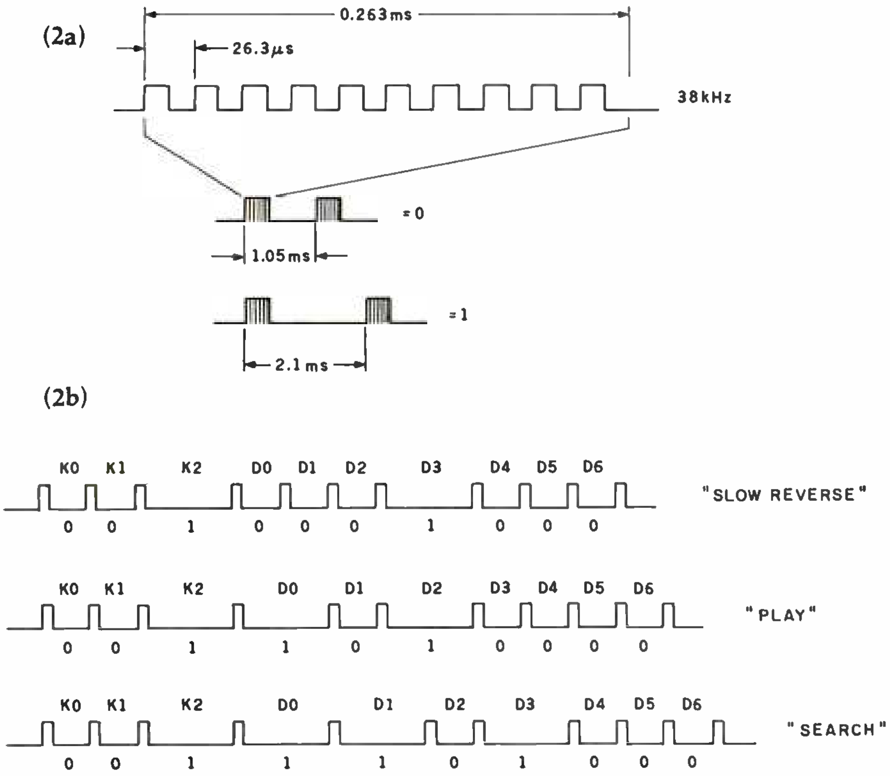


Figure 2: *Encoding of the VP-1000's control signals. Bursts of a 38-kHz carrier signal are sent in a pulse-code-modulation pattern to convey 25 different commands. The pulse bursts are shown in figure 2a; examples of real control codes are shown in figure 2b.*

which bits D0 through D5 are 01010. The format of the transmission is detailed in figure 2.

The 10-bit commands are transmitted as a series of bursts of a carrier frequency, with the bursts separated by a specified duration of time that determines whether a 1 or a 0 is being transmitted. Each pulse burst consists of 10 cycles at 38 kHz (kilohertz) and is exactly 0.263 ms (milliseconds) long, as indicated in figure 2a.

A 10-bit transmission starts with a burst and ends with a burst; it contains 11 bursts. The elapsed time between the beginning of one burst and the beginning of the next, defined as the *bit period,* can be either of two durations: 1.05 ms to indicate a logic 0 or 2.10 ms to indicate a logic 1. The actual length of a 10-bit transmission will vary depending upon the quantities of 1s and 0s. Three examples are shown in figure 2b.

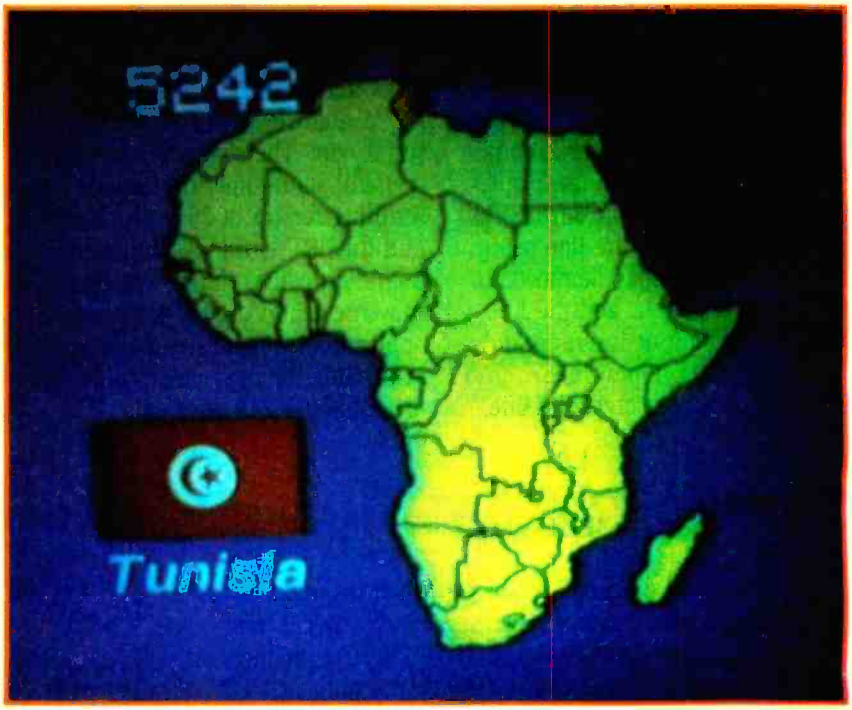
You can synthesize these codes in many ways. Depending upon your abilities, you may choose either a hardware- or software-intensive design. Generally speaking, if I have a choice, I always choose hardware. This time, however, synthesizing the control codes entirely in hardware would have unduly complicated the interface and only proven that I can make a mountain out of a molehill. Given the PCM coding used by the VP-1000, it's best to do much of the timing in software.

But old habits die hard, so I had to find someplace to wire a few chips. I have included two relatively simple hardware designs that are manipulated by software to varying degrees. Depending upon your programming talents, you might choose to reduce the hardware further.

Videodisc Controller: More Hardware

Figure 3 on page 68 is the schematic diagram of a relatively hardware-intensive controller design. Bit timing and pulse-burst generation are done with counters and one-shot multivibrators. The advantage of such a circuit is that it takes relatively little computer power and relies upon software only to provide the next code bit for transmission. I call this my full-

(4a)



(4b)

Photo 4: *In educational use, a computer program could ask a student to name the country associated with the flag shown in a still-framed video image, identified as frame 5241 in photo 4a. Then, to reinforce the answer, the program can call up frame 5242 (photo 4b) to show the country and its location on a map. Display of frame numbers is optional.*

CompuView

CP/M-86 Now Mainframe Features For Your IBM Personal Computer

The CompuView implementation of CP/M-86 for the IBM Personal Computer has the features needed to run the full range of CP/M-86 application programs. Included are serial and parallel printer support, a 'smart' screen driver which can emulate many popular CRT terminals, and 193K/drive disk capacity. Innovative features include built-in horizontal scrolling for up to 254 columns and screen line editing, which lets the user extensively edit or re-enter any command line on the screen for CP/M-86 and application programs. In addition to IBM hardware, the TECMAR, Inc. Winchester hard disk, other hard disks and 80 tpi double sided drives are also supported.

Screen line editing is a desirable, time saving feature common on large mainframe computers, but not previously available on any CP/M system. Besides editing the line being typed in, the cursor may be moved to any line on the screen, and the line edited by overtyping or inserting and deleting characters. Typing the 'Return' key will then enter the line, as it appears on the screen, to CP/M-86. Also, a string of 10 long commands can be repeated by moving the cursor to the first command and just typing the 'Return' key 10 times. This greatly reduces the amount of re-typing necessary due to mis-typed or repeated commands. Another common mainframe feature implemented is page control, which allows the screen to automatically stop after each new screen full of text.

The CompuView CP/M-86 is licensed from Digital Research and comes complete with all CP/M-86 utility programs. Software interchange is simplified by the ability to read and write IBM-MSDOS disks, IBM CP/M-86 disks and transfer files with other CP/M and CP/M-86 computers via the serial port. The screen driver includes a useful status line, horizontal scrolling for up to 254 columns, and faithful CRT terminal emulation, including editing functions, cursor movement and display attributes. Application programs can use the status line for their own purposes or to emulate a Z19 terminal.

We encourage you to compare our CP/M-86 with the version available from IBM. We have been careful to insure software compatibility and can read/write their disks. The table lists the major points of comparison between the two versions.

Compare CompuView With IBM

	IBM	CompuView
Horizontal Scrolling	No	Yes
Screen Line Editing	No	Yes
Page Control	No	Yes
Emulate popular terminals	No	Yes
'Smart' CRT functions	No	Yes
Read/Write IBM MSDOS disks	No	Yes
Serial file transfer	No	Yes
Support non-IBM hardware	No	Yes
Programmable Function Keys	Yes	Yes
Status Line	Yes	Yes
Support Light Pen	Yes	Soon
File Capacity	154K	193K

CP/M-86 for IBM P.C. $325

VEDIT-86 with above purchase (This version of VEDIT has horizontal scrolling for up to 254 columns) $100

V-COM Disassembler

Finally a Z-80 disassembler for CP/M which produces easy to read code, a cross reference table and handles INTEL and ZILOG mnemonics. V-COM is exceptionally fast and produces an .ASM file directly from a .COM file. The disassembly of a 12K program producing a 76K .ASM file containing 7500 lines of source code and a 33K cross reference file will typically take less than two minutes.

V-COM can accept two user created information files to *make the resulting* code more readable. One contains assignments of labels to 8 and 16 bit values; the second specifies the location of tables and ASCII strings. The resulting .ASM file will then contain labels and proper storage allocation for tables and strings. Each information file may contain nested 'INCLUDE' to other files. Each package includes a 30 page manual, sample program files and variations of V-COM compatible with TDL, MAC and two types of ZILOG assemblers $80

8086 Software

VEDIT full screen editor for CP/M-86, MSDOS, IBM Personal Computer and IBM Displaywriter $195

CP/M-86 BIOS for popular S-100 disk controllers and SCP 8086 computer. Source Code $90

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VEDIT

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VEDIT is user oriented to make your editing for program development and word processing as fast and easy as possible. The customization (installation) process makes VEDIT the only editing package that allows you to determine your own keyboard layout and use any available cursor and function keys. Just think of the difference it makes in your ease of learning and usage to type cursor and function keys instead of memorizing obscure control characters. This customization is menu driven, extends to much more and takes only a few minutes.

Unequaled Hardware Support

The CRT version directly supports over 35 terminals (including ANSI standard) in its installation menu and utilizes 'smart' terminal features such as line insert/delete, reverse scroll, status line and reverse video. Function keys on terminals like the Televideo 920/950, Heath H19, and IBM 3101 are all supported. The memory mapped version is extremely flexible, supports bank select such as on the SSM VB3 and screen sizes up to 70 X 200.

Sophisticated Full Screen Editing

VEDIT gives you true 'what you see is what you get' full screen editing with an extensive set of features for creating and editing standard text files of up to one diskette in length. Very large files are effortlessly handled by VEDIT's ability to edit up to 47K of a file entirely in memory without performing any slow and annoying disk accessing. And you can handle multiple files, insert a specified line range of another file anywhere in the text and even change diskettes.

User Oriented Features

You get the features you expect, like searching, a scratchpad buffer for moving and rearranging sections of text, complete file handling on multiple drives and flexible macros. For ease of use VEDIT has features you won't find elsewhere, like automatic indenting for use with structured languages such as Pascal and PL/I. You are less likely to make a mistake with VEDIT, but if you do, one key will 'Undo' the changes you just made to a screen line. And if you run out of disk space with VEDIT, you can easily recover by deleting old files or even inserting another diskette. It is therefore no surprise that VEDIT is the industry standard for program development editing.

Word Processing

VEDIT is suitable for simple stand-alone word processing, or it may be used in conjunction with a text processor. Its features include word wrap, adjustable left margin, reformatting of paragraphs, word oriented cursor movement and deleting, and imbedding of printer control characters. VEDIT can print any portion of your file and display the cursor's line and column positions.

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IC1	7400	14	7
IC2	7404	14	7
IC3	7475	5	12
IC4	74LS367	16	8
IC5	74121	14	7
IC6	74121	14	7
IC7	7474	14	7
IC8	74160	16	8
IC9	7404	14	7
IC10	NE555	8	1

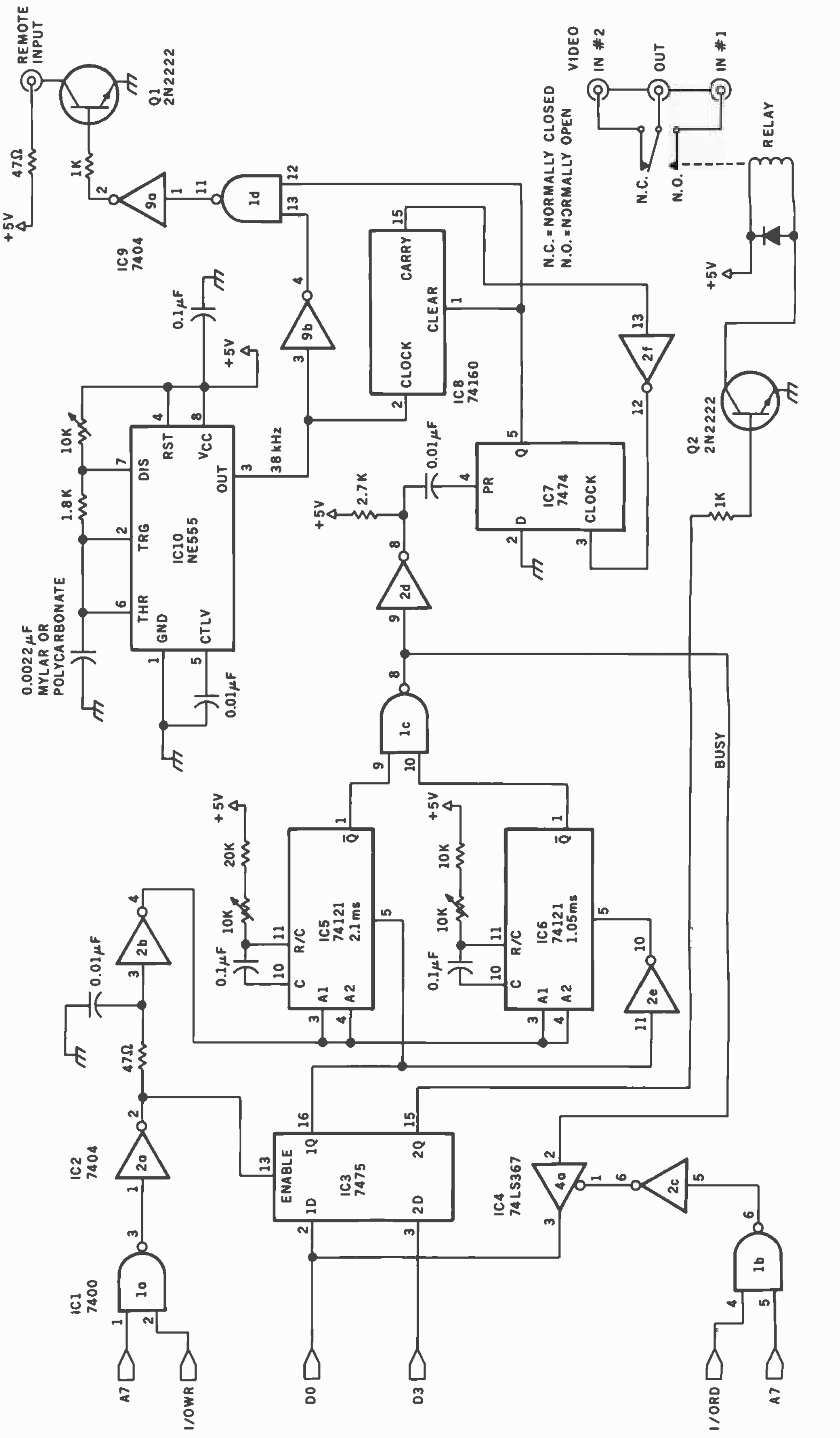

Figure 3: *Schematic diagram of a moderately hardware-intensive circuit to control the VP-1000 Laserdisc player from an external computer. Some software control steps are needed, notably the monitoring of I/O port hexadecimal 80 to determine when the interface can accept the next bit of the control code.*

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hardware approach, which is used according to the flowchart and typical program sequence shown in figure 4 on page 70.

The interface is designed to communicate with a microcomputer via an I/O (input/output) port at hexadecimal address 80. To transmit the 10-bit control code (which has been selected and formatted by some other high-level program), the computer first outputs the first control-code bit (K0) to port 80 as a logic 0 in the LSB (least significant bit) of the data bus (K0=0) or as a 1 in the LSB (K0=1). This value is loaded into the bistable latch IC3.

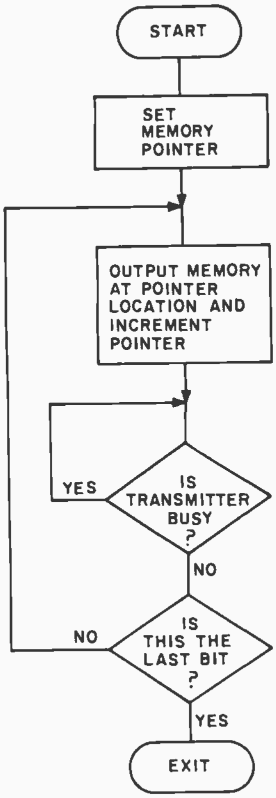

Figure 4: *Flowchart of the algorithm to control the Laserdisc player using the hardware of figure 3. Typical microprocessor code (Z80) is shown in listing 1.*

Listing 1: *Assembler code for the Z80 microprocessor to perform the algorithm of figure 4, controlling the interface of figure 3.*

```
         LD HL, POINTER
AGAIN    LD C, PORT
         OUTI
         CALL TEST
         LD A,L
         CP END
         JNZ AGAIN
TEST     IN A, PORT
         BIT 7,A
         JP 0, TEST
         RETURN
POINTER  EQU  8000
PORT     EQU  80
END      EQU  8008
```

Depending upon this logic level, one of the two one-shots IC5 or IC6 will fire when IC3 is loaded. If the control-code bit is 0, then IC6 fires; if the control-code bit is 1, then IC5 fires.

The computer monitors the outputs of the two one-shots by testing the LSB of input port 80. If bit 0 is high when examined, then the interface is still busy transmitting the control-code bit. When the port's LSB indicates a logic 0 again, the interface has finished transmitting, and the computer program should output the next control-code bit to port 80.

The variable timing that sends a 1 or 0 is handled in hardware, with the computer cued to send the next bit by a Busy/Not-Busy signal from port 80. All the program has to do is simply monitor the Busy line and output the 10-bit VP-1000 control code one bit at a time. As shown in listing 1 accompanying figure 4, the program is barely 20 bytes long (written for a Z80 microprocessor).

The rest of the hardware in figure 3 produces the pulse burst. The flip-flop IC7 and the decade counter IC8 form a 10-cycle counter clocked by a 38-kHz oscillator (the timer IC10). When one of the one-shots fires, timing a bit period, the leading edge of this signal presets flip-flop IC7 and raises the Clear line on IC8 (allowing it to count). IC8 counts until it reaches 9 and then generates a carry pulse when it rolls over. This carry pulse clears the flip-flop and stops the counting process until a one-shot is triggered again. During the counting period, the 10 clock cycles (the 38-kHz pulse burst) are transmitted to the VP-1000. The timing between pulse bursts is controlled by the computer monitoring the busy line.

One extra item in figure 3 is a relay. The relay is enabled by bit 3 of the input port 80 and can be used to switch a single video monitor between two video sources. One source could be the output of the computer's regular display, while the other could be the videodisc player's output. Using the relay, the computer could display some appropriate material from the videodisc and then switch the screen back to the computer's own output to pose a question about the contents of the videodisc program.

Videodisc Controller: Less Hardware

Figure 5 on page 72 shows a more software-intensive approach, which uses just the pulse-burst generator from figure 3. A flowchart of the algorithm to use this circuit is shown in figure 6 on page 74. As all timing except for the carrier is done in software and this circuit is triggered by a pulse rather than a discrete logic level, a data latch is unnecessary. Bit timing is still important, but a few microseconds here or there won't make much difference.

As configured, the control program should allow either 1.05 or 2.10 ms to elapse (depending upon the control-code bit value) and then activate the pulse-burst generator. In my opinion, this method is preferable to the hardware-intensive design of figure 3.

As I have described, handling the entire communication between the computer and the videodisc player is simply a matter of timing and logic switching. If you have just a parallel output port on your computer and excellent skill with software, you could conceivably synthesize the entire command sequence, including the 10-cycle 38-kHz pulse burst, entirely in software. At only 26.3 microseconds per cycle, however, you will have to code a tight program without many branches and subroutines. Because such a program has to be machine-specific and coded with the clock speed of the processor in mind, I decided to forego the exercise for this article.

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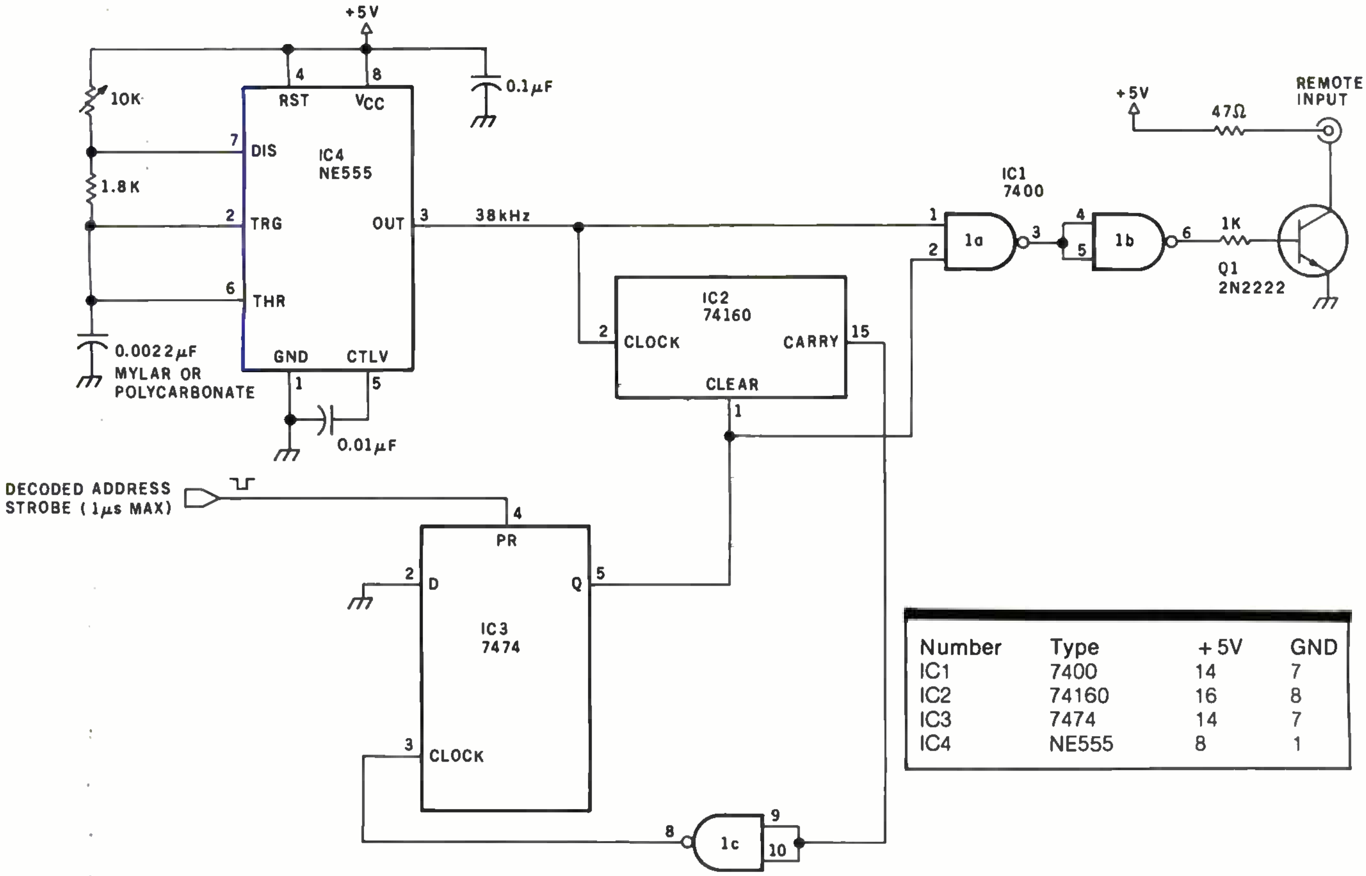

Number	Type	+5V	GND
IC1	7400	14	7
IC2	74160	16	8
IC3	7474	14	7
IC4	NE555	8	1

Figure 5: *A simpler circuit for controlling the VP-1000 Laserdisc player that relies somewhat more on software to perform timing of the pulse bursts.*

Photo 5: *Great works of art are reproduced on videodiscs; the applications for a computer-assisted art-history project are plentiful. Here we discover that Vincent van Gogh was an early user of Motorola microprocessors.*

power of its machines while minimizing the cost per bit of online storage. Increasingly, 10-megabyte or larger Winchester-technology hard-disk drives are spoken of as required peripheral devices as more and more computer applications are developed that require storage and use of large amounts of data.

We should take care not to overlook the technical possibilities of the Pioneer Laserdisc and its kin while viewing *Star Trek* and *The Jerk*. The laser-optical videodisc player is a mind-boggling 20-gigabit random-access read-only memory that costs only $600. Try pricing that storage on any kind of magnetic disk!

Eventually, optical storage discs will be produced which contain vast databases, not simply as video still frames, but as computer-readable program code and data files. Instead of pictures of 10,000 pages of text, the disc will simply contain the text stored as ASCII (American Standard Code for Information Interchange) files. Then several billion characters could be stored.

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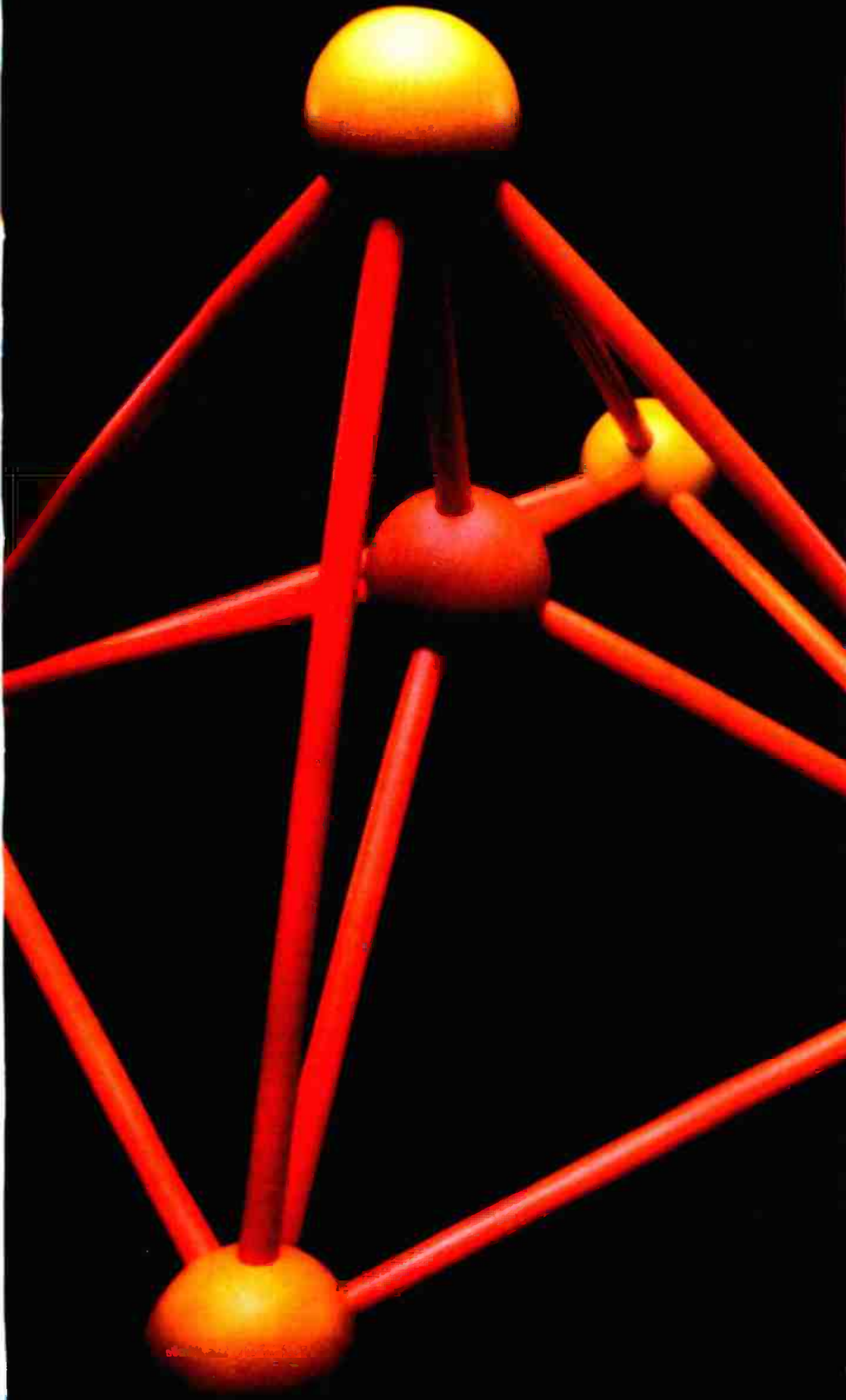

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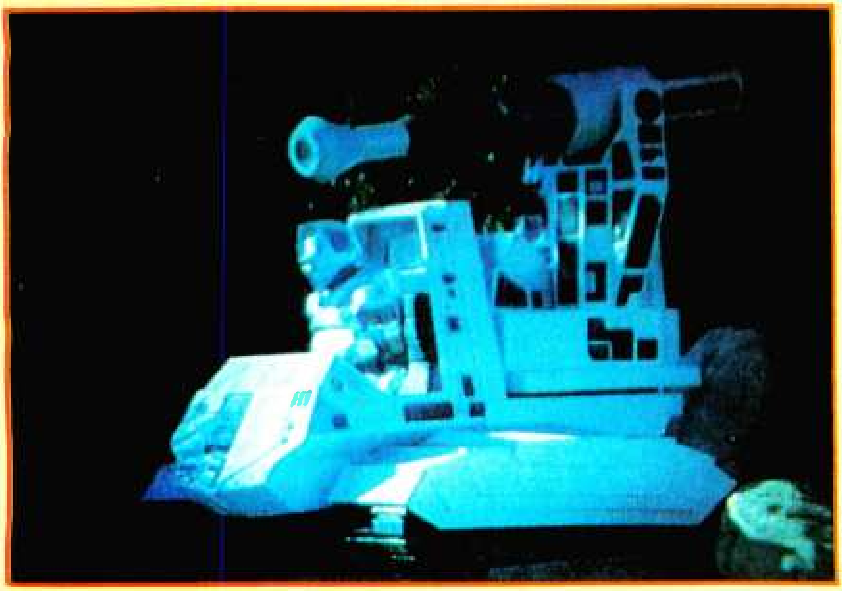

Photo 6: *Computer game fans will use their computer-interfaced videodisc players for fun, perhaps playing a space-war game spiced up with images from* Battlestar Galactica. *The video images reproduced in this article were photographed from a Pioneer LS-501 large-screen projection television receiver.*

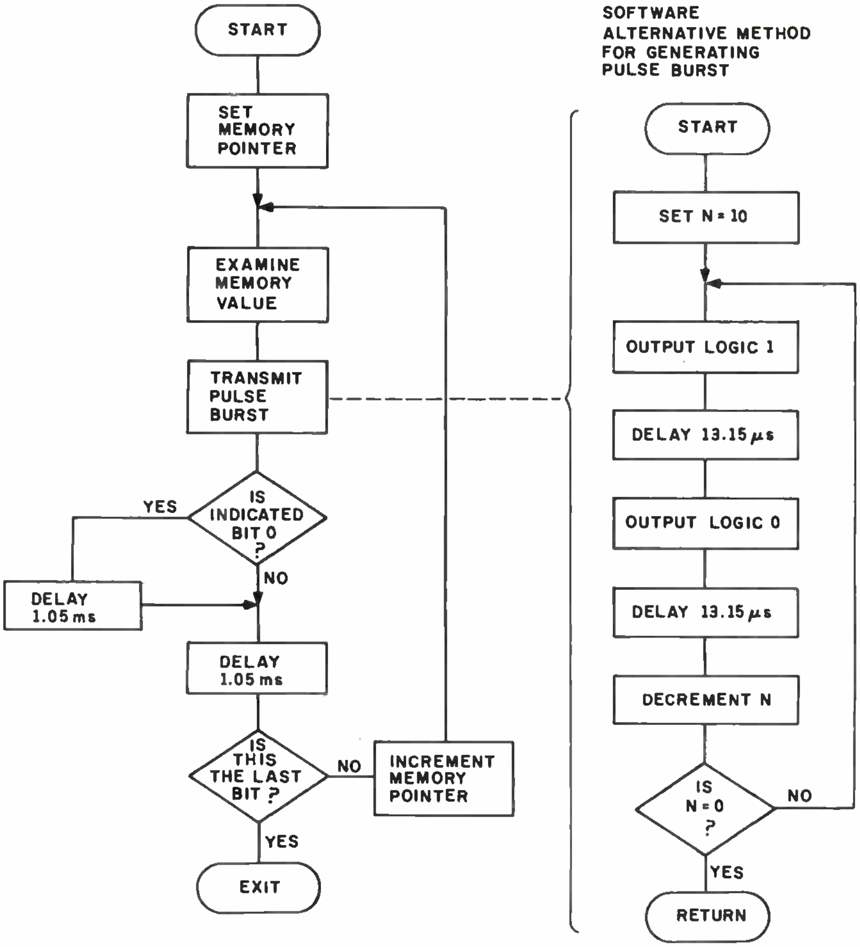

Figure 6: *The algorithm to control the Laserdisc player using the circuit of figure 5. Clever, tight coding could produce a program that can handle all of the timing and make the needed hardware even more simple.*

The real breakthrough in videodisc technology will come with the ability to record as well as play a disc. While some descendant of today's videodiscs might become a fully flexible read/write medium, it appears that the first such machine to appear might be a gigantic write-once read-only memory, or WOROM.

In Conclusion

The technology is still in its infancy today, but I expect that eventually optical videodisc players will become not only practical but necessary computer peripherals. For the present, however, our computer interfaces will have to wait for material suitable for video/computer interaction.

Considerable effort is being expended in the production of educational and scientific discs, but I am sure you can expect one of the major software suppliers to have a videodisc specially produced for adventure games. For my own use of the Laserdisc player, my controller will be there when computer-applicable material arrives at my door. But right now, I think I'll sit down and watch a cooking-class disc. I heartily recommend the *clams cassino.*

Next Month:

When we've finished working with video, we can turn our attention to audio. In July we'll see how to create sound effects using a new integrated circuit from Texas Instruments. ■

Editor's Note: *Steve often refers to previous Circuit Cellar articles as reference material for each month's current article. Most of these past articles are available in reprint books from BYTE Books, 70 Main St., Peterborough, NH 03458.* 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 the articles that were published from July 1980 through December 1981.*

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Videodiscs in Education

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Interactive videodiscs are entering the classroom.

Dr. Isaac I. Bejar
Educational Testing Service
Princeton, NJ 08541

Both the communications and computer industries have achieved tremendous growth but, for the most part, have developed unmindful of each other. Their disagreement over legislation to deregulate the communications industry suggests both are beginning to step on each other's turf. Now that the antitrust cases against AT&T and IBM have been dropped, some predict the two industries will eventually coalesce into a new information industry. The recent coming of age of the videodisc, a product that integrates both technologies, suggests that the prediction may be valid.

Both the communications and computer technologies have a long, and perhaps sad, tradition in education. Critics often refer to educational television as a "failure." That characterization is probably not fair to much of today's educational television, but the early attempts were certainly affected by a lack of understanding of the medium. Some of the early experiments on the effectiveness of television as an instructional medium were little more than comparisons of a live lecturer and a "talking head." No wonder many of these experiments showed "televised" instruction to be no better than live instruction.

Today, while less than inspiring educational programs continue to be produced, a fair amount of good educational television does exist. Moreover, the medium's potential effectiveness for educational purposes is gradually being established as suggested by the evaluation of Sesame Street (see reference 1) and other programs.

The computer has also had a mixed history in education. While the technology's potential was realized by some of the early innovators, the realities of the marketplace prevented the predicted boom of computers in education (see reference 2). Because software developers were not sure of the market, they did not strive to produce the best possible product. This led, in turn, to poor acceptance of the software, which fulfilled the developers' own prophecy.

However, the effectiveness of CAI (computer-assisted instruction) now seems established judging by the results of several projects including a large-scale field test being conducted in Los Angeles public schools by the Educational Testing Service for the National Institute of Education. On the market side, the cottage industry that has provided educational programs is now beginning to be supplemented by established publishers.

Together, these trends suggest that at last technology is gaining a foothold in education, and because of this, the videodisc may be more readily accepted into the classroom than television or computers.

Nevertheless, caution is necessary. From a historical perspective, the current educational application of videodisc technology stands at a point equivalent to the early years of educational television and CAI. The collective results of current projects are bound to have a significant impact on the future of videodisc technology in education. Therefore, the technology must be given a fair chance to demonstrate its effectiveness, which will be a function of tangible factors, such as the quality of the hardware and software, as well as intangible factors, such as the attitudes of teachers toward technology. This article concentrates on the tangible factors by

About the Author

Isaac I. Bejar is a Research Scientist at the Educational Testing Service.

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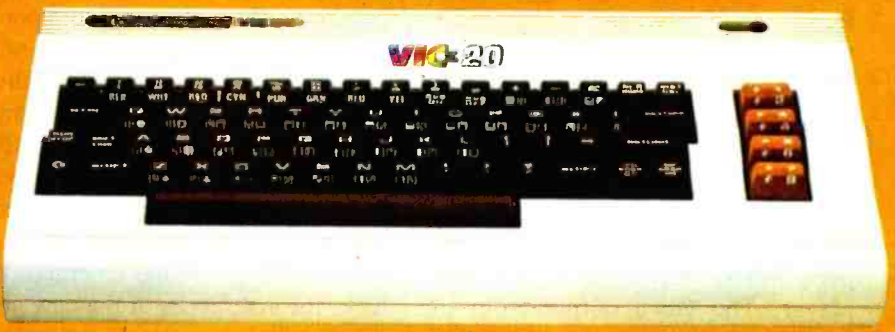

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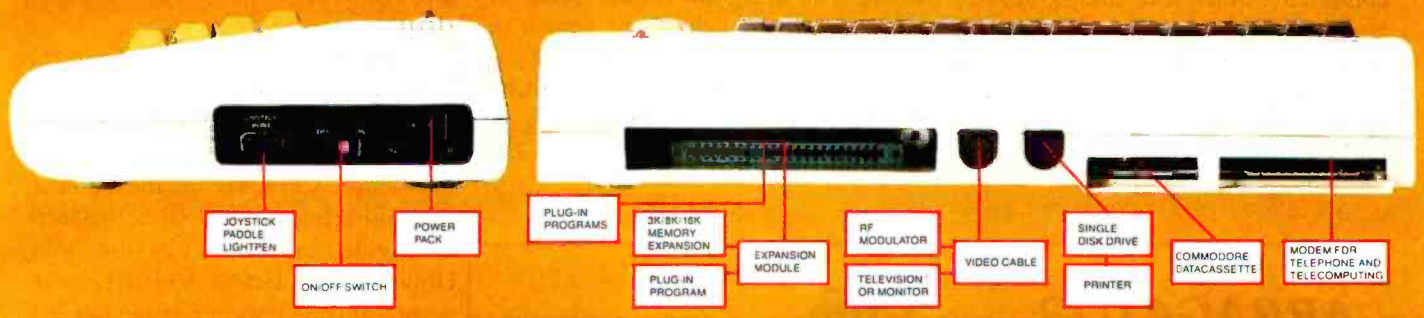

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Upper/Lower Case Characters	YES	YES	YES	NO
Operates with all Peripherals (Disk, Printer and Modem)	YES	NO	YES	YES
Full Screen Editor	YES	YES	YES	NO
Microsoft Basic	Standard	N/A	N/A	$ 99.00
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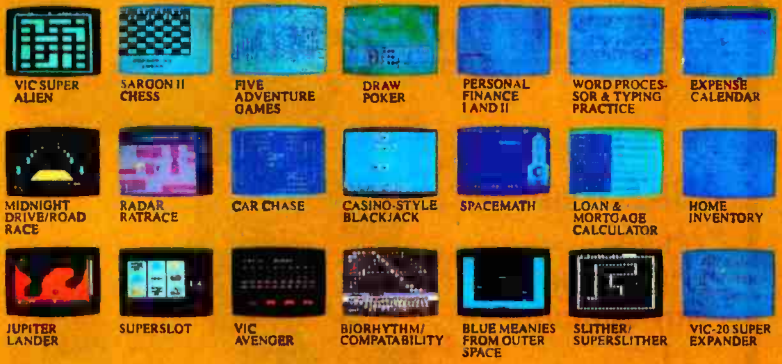
*Manufacturer's suggested retail price Mar. 1, 1982



Read the chart and see why COMPUTE! Magazine[1] calls the VIC-20 computer "an astounding machine for the price." Why BYTE[2] raves: "...the VIC-20 computer unit is unexcelled as a low-cost consumer computer." Why Popular Mechanics[3] says "...for the price of around $300, it's the only game in town that is more than just a game." And why ON COMPUTING INC.[4] exclaims: "What is inside is an electronic marvel... if it sounds as if I'm in love with my new possession, I am."

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[1] April '81 issue [2] May '81 issue [3] November '81 issue [4] Fall '81 issue

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exploring hardware-software considerations and courseware (instructional or educational software) issues and leaves the intangible factors for another occasion and forum. An ongoing project concerned with applying videodisc technology to the teaching of elementary mathematics has provided a framework for the discussion that follows.

Hardware-Software Considerations

Our research is oriented toward the development of individualized learning stations. That is, we envision an environment where individual students will have access to a computer which, in turn, will control several peripherals, including a videodisc player. The video output from the computer, both text and graphics, and the video from the videodisc will appear on a single screen. Input to the computer will be through a keyboard, light pen, and eventually natural speech.

Choice of computers: An important principle in choosing a computer system for an educational environment is to distinguish between development and delivery systems. You need a development system to facilitate authoring, i.e., the creation of both textual and graphic materials and the selection of audiovisual materials. A delivery system need only be capable of delivering and managing the instructional materials. In principle, you need a substantially less expensive machine for delivery purposes. Choose the development system with an eye toward transporting the results to a delivery system. Because research takes time, often by the time the project ends a new generation of hardware has emerged. With luck, the emergence of the new generation will bring down the price of what was the development system to such an extent that you can justify it as a delivery system, thus obviating the need to transport everything to the new machines.

This reasoning suggests that it would be inappropriate to base research and development effort entirely on the current crop of computers because they are now near the end of their life cycle. For example, the TRS-80 has definite limitations, such as the difficulty of going beyond 48K bytes of memory and implementing standard operating systems, such as CP/M. The Apple also has a serious limitation in the use of a nonstandard video signal, which makes it difficult to integrate the video output from the computer and videodisc. (As it turns out there is a board from Video Associates Lab that makes this possible, but the board itself costs more than the Apple. Also Adwar sells a black box, the ARS-170, that brings the Apple video signal up to National Television Standard Code [NTSC] standards.)

A second determining factor in the choice of a computer is the availability of software to facilitate the authoring process as well as the delivery of instruction. Currently the most powerful authoring system that supports both video tape and videodisc is the University of Utah's Video Courseware Implementation System (VCIS). The system runs under UCSD Pascal on a Terak 8510/a computer. We chose the Terak-VCIS combination as our development system because, theoretically, with it you can use any machine running under UCSD Pascal as a delivery system.

The Terak is a 16-bit, medium-resolution (256 by 320), black-and-white graphics computer based on the LSI-11 processor. Our system has 56K bytes of memory, two double-density disk drives, one serial port, a keyboard, and a display. The educational price was close to $8000. The documentation is not extensive, but over-the-phone technical support has been excellent. Two operating systems are available for the Terak, UCSD Pascal and RT-11. You can upgrade the Terak 8510/a for high-resolution color, but this costs several thousands of dollars.

Choosing a videodisc player: Three competing videodisc systems are on the market today. These include the RCA Selectavision, which is based on

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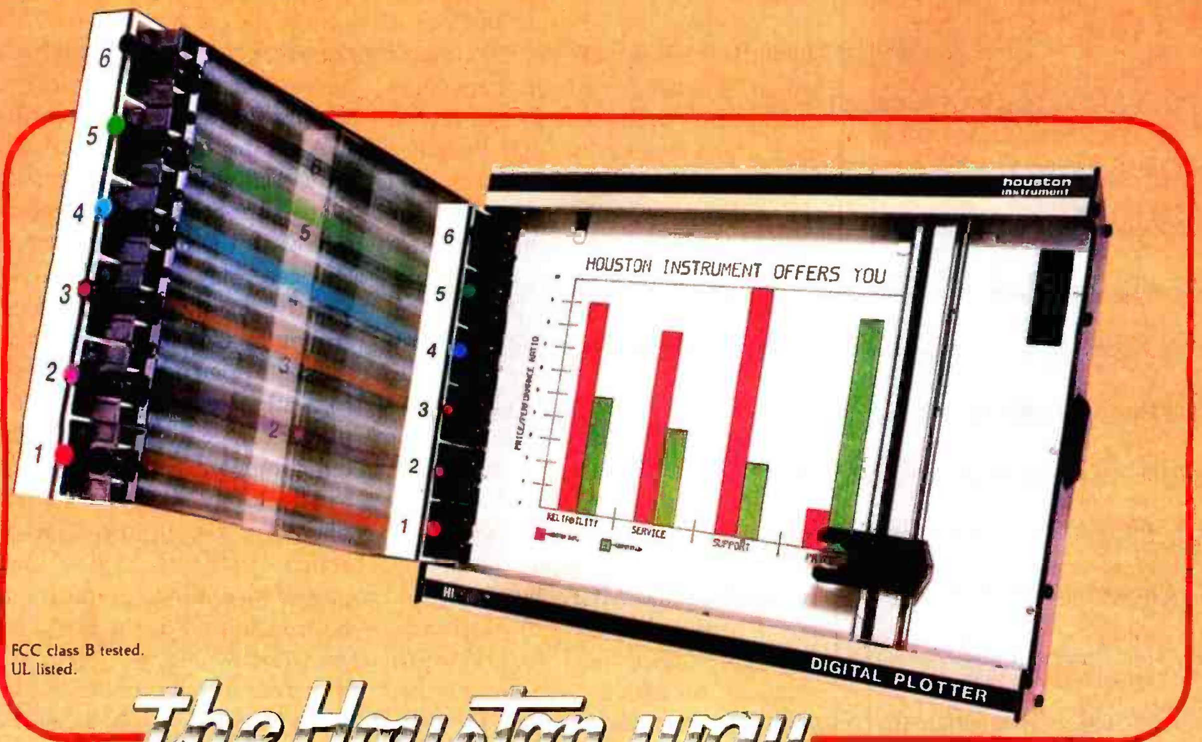

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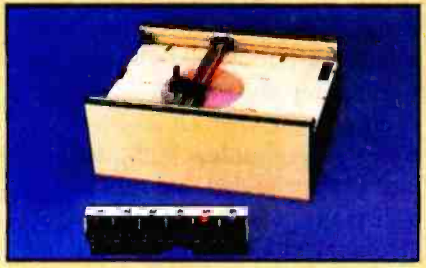

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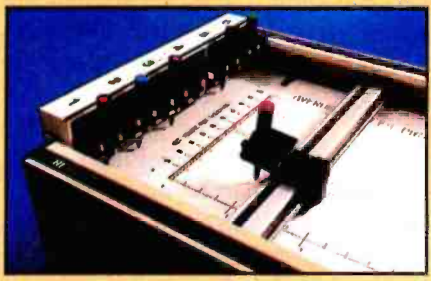

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the capacitance electronic disc (CED) system. In this system, the audiovisual information is engraved on a plastic disc and is picked up by a stylus making physical contact with the grooves of the disc. A second system, produced by Matsushita-JVC, is the video high-density (VHD) system, which is also based on capacitive pickup but, unlike the RCA system, uses a grooveless disc that does not have to make physical contact with the pickup. Finally, there is the optical-laser system which uses a laser beam to pick up the audiovisual information without making physical contact with the disc. Actually, two types of laser systems are available: one, manufactured by Thompson-CSF, is called transmissive, and the other, manufactured by Sony, Pioneer, Magnavox, and Discovision Associates (DVA), is reflective. (Most of DVA, formerly a joint venture between IBM and MCA, has been sold to Pioneer. For convenience, however, I will refer to DVA products in this article even though they may now be marketed by Pioneer.) The transmissive disc is soft, while the reflective disc is rigid and requires no special handling at all, thus making the optical-laser-reflective-disc technology the most congenial for educational applications. I will focus on the laser-reflective-disc technology.

The laser-reflective videodisc players come in "consumer" and "industrial" models. The primary consumer models are sold by Pioneer and Magnavox and can be bought at discount for less than $600. Both Sony and Discovision Associates manufacture and retail industrial players for close to $3000 depending on what options you choose. Naturally, the industrial models are sturdier and have more features. For one thing, they have their own onboard microprocessor, a Z80 in the case of the Sony, and an F8 Fairchild in the case of the DVA unit. They also have 1K bytes of RAM (random-access read/write memory) for storing programs. Although the players are not programmable in BASIC, the instructional language is fairly straightforward. The consumer videodisc players, however, are not directly programmable, but the Pioneer can be interfaced to a host computer.

We chose the industrial DVA model. While it is currently outrageously expensive, chances are that many of its features will find their way to the consumer model. Thus, by choosing a state-of-the-art machine, we protect ourselves against some of the problems mentioned earlier.

An important characteristic of the industrial videodisc player is its ability to support two-way communication with the host computer. For the Pioneer player, communication is strictly one-directional. That is, the computer can instruct the videodisc player to perform a task, but no information regarding the status of the player can be transmitted to the external computer.

The Sony and DVA videodisc players make information on their status available. With the DVA player three kinds of information can be transmitted to the host computer:

- current frame number
- the contents of RAM
- the player status (for example, whether it's playing forward, searching for a frame, etc.)

Of these, the capability of transmitting the current frame number is most important for instructional purposes (more on this later). For the Sony player, the standard port for communicating this information is a built-in RS-232C, whereas for the DVA player, it is a nonstandard parallel port. However, DVA sells an RS-232C interface that allows any computer with a serial port to communicate with the player.

Integrating the computer and videodisc output: While you can use any computer with an RS-232C port to communicate with either the DVA or Sony player, unless additional interfacing is provided, you will need two displays, one for the video output from the videodisc player and one for the computer display. Two displays are more expensive and, in an instructional setting, may have a distracting effect. Fortunately, a number of firms have developed interfaces that allow the computer and the


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Break in 1430
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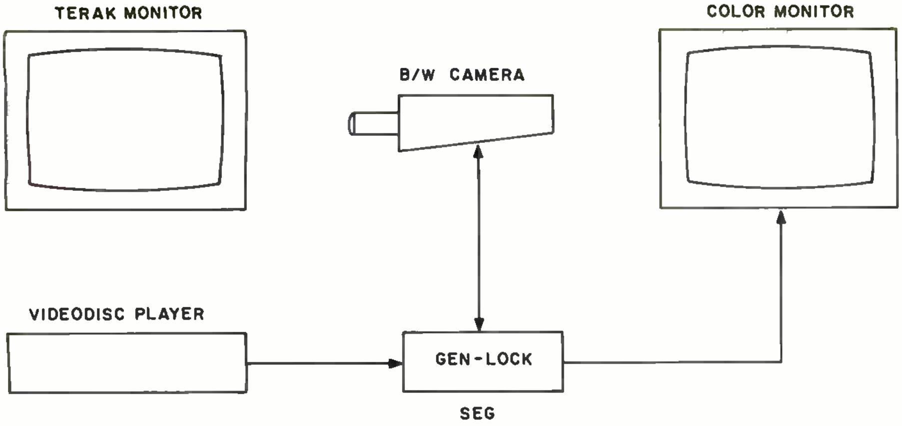


Figure 1: *System used to produce photo 1. This arrangement can be used to overlay text and graphics that appear on the Terak monitor over the video output from the videodisc player. The black-and-white camera and the videodisc are synchronized through the special-effects generator (SEG). The composite video from the videodisc is sent to the genlock input of the SEG, which in turn locks the sync of the black-and-white camera.*

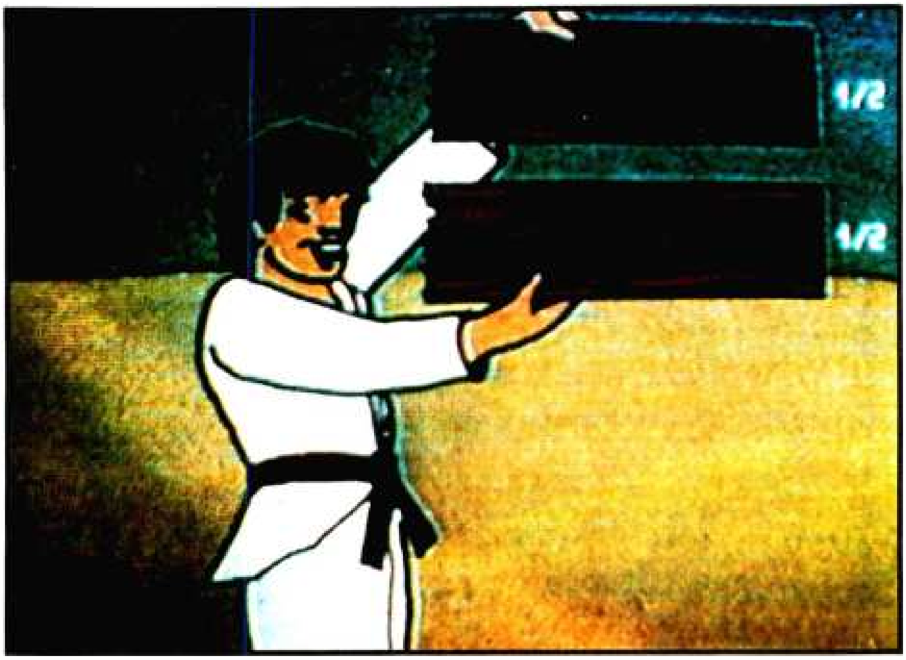


Photo 1: *An example of text keyed over another video source. A black-and-white Sony video camera (AVC-3250) was pointed at the Terak screen. The camera was synchronized to the videodisc with the Sony special-effects generator (SEG 1-A). The output was displayed on a Sony monitor (VM-2150).*

videodisc player to share the same display. Some of these firms are listed at the end of this article. These interfaces not only control the videodisc but also switch, under computer control, between the two video sources.

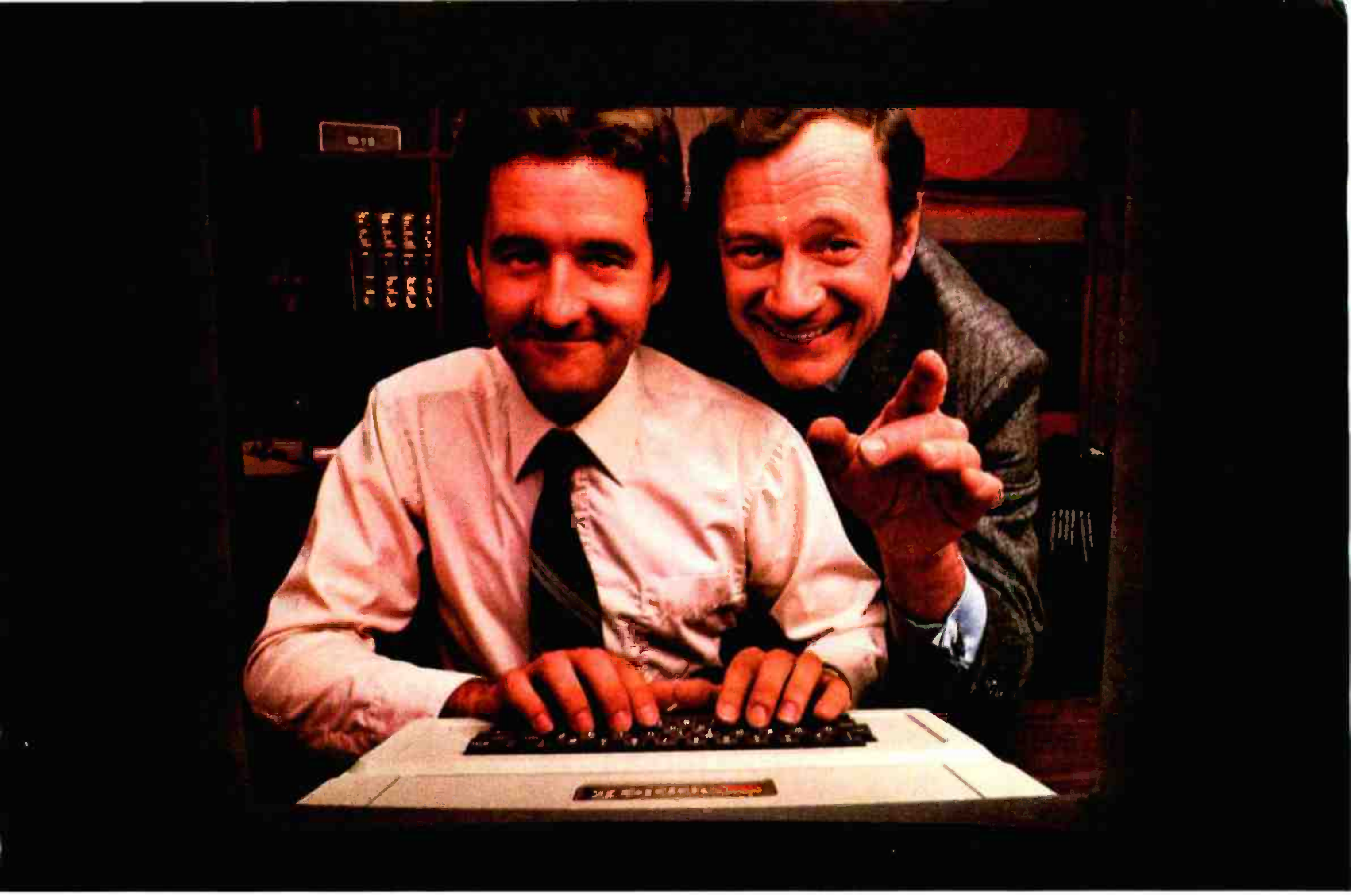
A still higher level of integration requires not only that the computer and videodisc share the same display but that both video signals be shown simultaneously. In an instructional setting, this opens up a new dimension for courseware development. For example, the same video segment could be used for different purposes by "overlaying" different text and graphics. One approach to accomplishing this integration combines the two video signals, while the other approach dumps the computer screen, much as one would dump the computer screen to a plotter, into an interface that regenerates the screen and superimposes it on the videodisc output.

The crudest implementation (see figure 1) requires a black-and-white camera capable of accepting external sync and a special-effects "keyer." The special-effects keyer locks itself to the sync pulses from the player. The black-and-white camera, in turn, accepts sync from the special-effects keyer. As a result the black-and-white camera video output (which is a replica of what is being displayed by the computer, be it character or graphics) and the videodisc video output are in perfect sync. The internal circuitry of the special-effects keyer takes care of integrating the two video signals. Because the keyer is constantly integrating the two signals, to display one or the other, it is necessary to blank the corresponding screen.

The results of the approach are illustrated in photo 1, a picture of the color-monitor screen. The still is from Infinity Factory, an educational series very popular in schools and recently put on disc by the U.S. Office of Education. (I'm grateful to Dr. Frank Withrow for providing the set of discs.) The fractional numbers were overlaid with the setup illustrated in figure 1. The readability of the numbers is not great because the regular character set was used. You can use a "wide" character set yielding 40 instead of 80 characters per line to improve readability.

You would need a monitor, the black-and-white camera, and the special-effects keyer to implement this approach—a cumbersome arrangement. On the other hand, this setup can be used with any computer and is fairly inexpensive.

An improvement upon the configuration shown in figure 1 is to bypass the black-and-white camera by feeding the computer video directly into the special-effects keyer. Because computers are not designed to accept external sync, this is far easier said than done. As you might suspect, the key to the problem is synchronizing the computer and videodisc video output.



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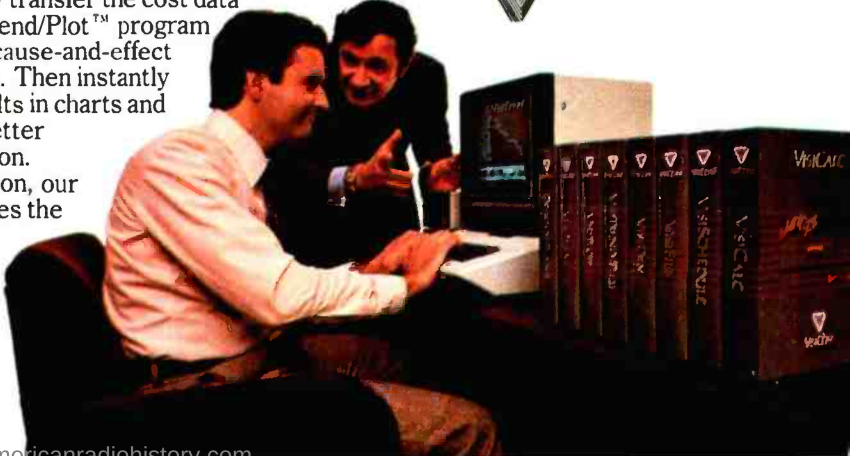

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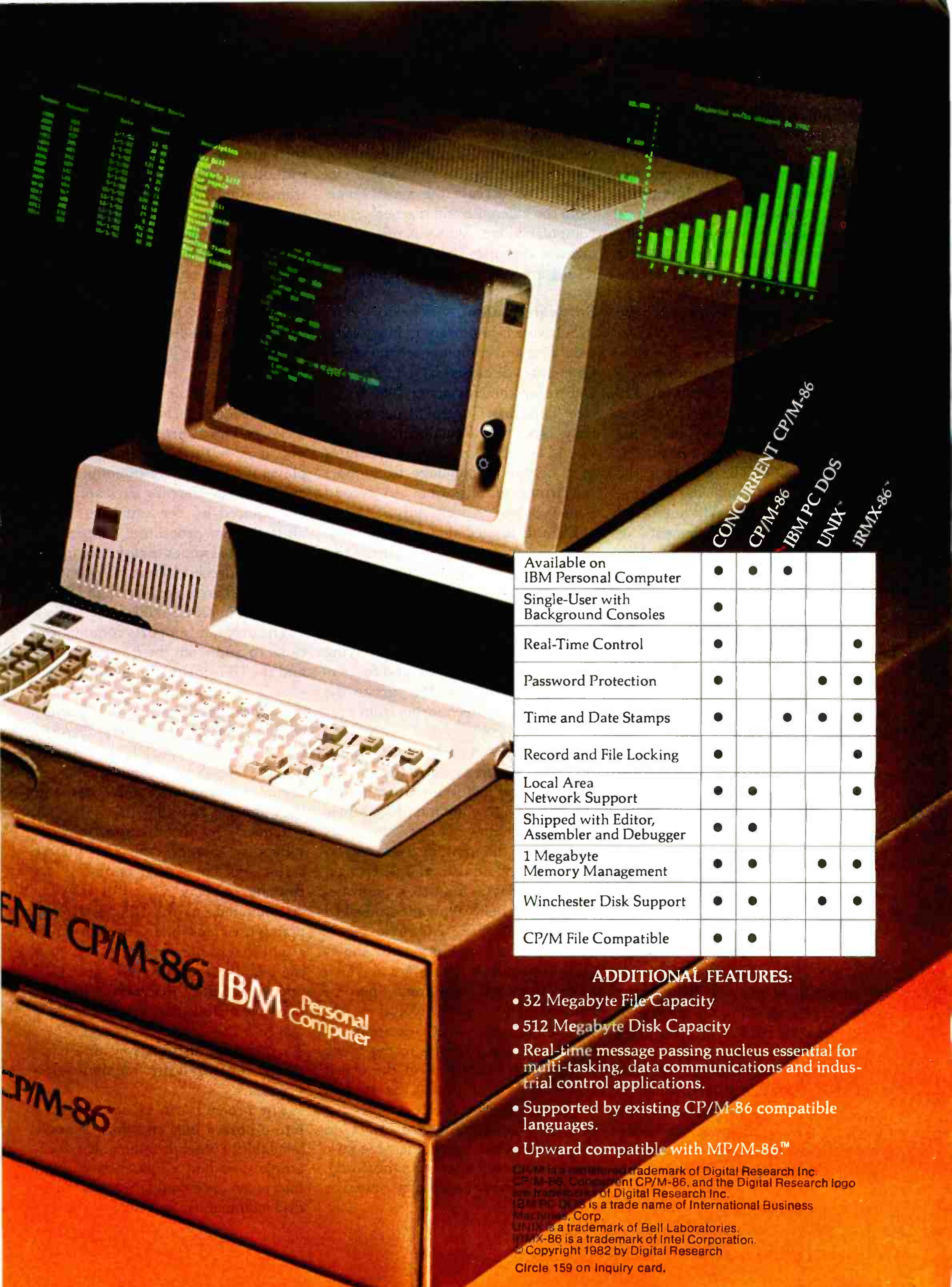

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To appreciate the problem, remember that television images, like movie images, are created by rapidly displaying frames. For movies, 24 frames per second is the standard; for television the standard rate is 30 frames per second. Whereas for film the frame is a piece of celluloid, for television a frame consists of an electronically created image displayed for 1/30 of a second. That image is "painted" on the screen by an electron gun, the input to which is a video signal that could have originated at a video-tape player, videodisc player, or camera. This electron gun paints one line at a time on the screen. A frame consists of 525 lines; however, for technical reasons (see "A Simplified Theory of Video Graphics, Part 1" by Allen Watson III, November 1980 BYTE, page 180), the painting is done in two fields. The first field consists of the odd-numbered lines, while the second consists of even-numbered lines. This is called interlacing.

By now you are wondering how the electron gun knows to jump to the next line as well as to the beginning of the screen when a field is completed. Horizontal and vertical sync pulses provide this information. The horizontal sync pulse tells the gun to jump to the left uppermost corner of the screen. Because there are two fields per frame, two such pulses occur in the video signal comprising a frame. Similarly, the vertical sync pulse tells the gun to go to the beginning of the next line. Two video signals are synchronized when their vertical and horizontal sync pulses occur at the same instant.

To my knowledge, no available computers or video boards accept external sync. Moreover, manufacturers of personal computers have done away with interlacing to cut costs. Thus, the sync pattern of a standard (i.e., interlaced) video signal is inherently incompatible with the sync pattern of most computers. Much to our chagrin, we found this to be true of the Terak also. However, we are experimenting with a modification to the Terak video circuit to get around this difficulty, as well as to have the Terak accept external sync.

The second approach to integrating computer and videodisc output is to digitize the contents of the computer video and send it over to an interface (which in reality is another computer). The interface has its own video circuitry that accepts the sync signals from the videodisc and regenerates the computer video. Syntec is one manufacturer that uses this approach. The results are very good but expensive.

Software Issues

Software is important in integrating videodisc and computer technologies. One issue, discussed by Dr. Thomas DeFanti in the November 1980 BYTE (see "Language Control Structures for Easy Electronic Visualization," page 90), is the need for control structures in a computer language to support "electronic visualization." A second issue is software portability.

DeFanti argued that existing computer languages do not contain control structures capable of creating and manipulating electronic images in real time. Likewise, the software support for videodiscs in education often lacks this capability used for overlaying video (as I just discussed) and for permitting responses on the part of the student other than choosing from a set of alternatives.

For example, in the teaching of fractions students are expected to learn the symbolic and pictorial representation for fractions. A common procedure is simply to show circles and bars colored to different degrees corresponding to various fractions. Using a videodisc player, a possible improvement would be to allow the student to construct an appropriate circle or bar. This could be accomplished by showing a sequence of 100 frames in which each frame has an additional 1 percent colored. The student would be instructed to single-step back and forth within these 100 frames to the frame that has, say, one half of the object colored. At that point, the student could indicate his choice by pressing Return. The program, in turn, would determine what frame the videodisc player was on. If it were on the fiftieth frame, the answer would be scored as correct.

This same procedure could be implemented using computer graphics, but the program would tend to be hardware specific. By contrast, the software to communicate with the videodisc player can be more transportable. Moreover, video stills can be made more realistic. For example, the above sequence could be done with a child pouring a liquid into a container. The student's task then becomes to locate the frame that corresponds to, say, a half-filled container.

To use a videodisc in this fashion, as opposed to using it as a repository of visual segments, requires underlying software to exploit the capabilities of the videodisc. I have developed a series of Pascal procedures that support most of the commands the DVA player is capable of responding to, including single-stepping back and forth as required by the examples given above. The procedures appear in listing 1. It assumes that the computer and the videodisc player (DVA model PR-7820-2) are linked through DVA's universal interface (UEI).

The program supports communications to and from the host computer and the UEI, including the following:

- Commands to the videodisc player, such as STOP, DISPLAY FRAME NUMBER, TURN AUDIO on TRACK 2 OFF, etc. Some commands have arguments associated with them, and they are sent as well.
- Requests for information from the videodisc player: current player status, current frame number, and contents of memory.
- Commands to the UEI. The commands used most often are 'D1', which establishes communication between the UEI and the computer, and 'D2', which requests the interface to echo back commands that are sent to it.

The program also employs an exception status to indicate communication problems.

The program can be easily turned into a library unit and thus be made available to other programs. If, for example, you had a Pascal-based Pilot interpreter, you could then add videodisc commands to Pilot. (It is my

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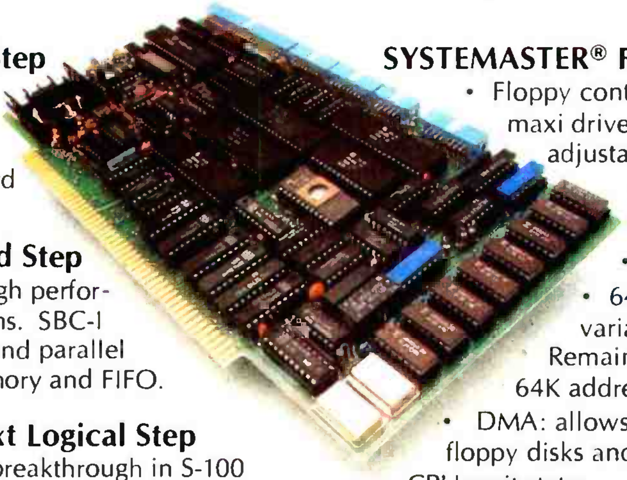

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understanding that the next release of Apple Pilot will support communication with a videodisc. Also, the International Institute of Applied Technology has announced a CP/M-based Pilot that supports videodisc commands.)

Because, inevitably, different schools will have different computers and because software development costs are constantly growing, you should develop software that can be run on a number of different computers. The UCSD operating system

Text continued on page 96

Listing 1: *Pascal procedures for controlling the DVA PR-7820-2 videodisc player through DVA's universal interface. The program is written in UCSD Pascal for the Terak computer and allows the computer to communicate in both directions with a DVA player. Specifications for writing the program were derived from two manuals from DVA (see vendor list).*

```
{****************************************************************************}
CONST
  CR=13;{   CARRIAGE RETURN}
  LF=10;{   LINE FEED      }
  CS=12;{   CLEAR SCREEN   }
  LFR=4;

TYPE
STR4=       PACKED ARRAY[0..LFR] OF CHAR;
STR1=       PACKED ARRAY[0..1] OF CHAR;
VAR
  ERROR:     STR1;{ERROR CONTAINS THE ERROR ISSUED BY UEI.}
  FRAME:     STR4;{CONTAINS THE ARGUMENT NEEDED BY SOME COMMANDS.}
  COM:       CHAR;{ HOLDS THE VIDEODISK COMMAND}
  FRAMENO:   INTEGER;{FRAMENO IS THE VALUE RETURNED IN RESPONSE TO}
                          {THE DUMP FRAME COMMAND.}

  FRLEN:     INTEGER;{FRLEN IS THE NUMBER OF DIGITS IN FRAME.}
  RWS:       STR4;{WORK STRING TO RECEIVE BYTES FROM UEI.}
  TWS:       STR1;{WORK STRING TO TRANSMIT TWO BYTES TO UEI.}
  {************************************************************************}
FUNCTION READCHR:CHAR;
{ Reads one character from the keyboard.}
VAR
  X:  CHAR;
BEGIN
READ(X);
READCHR:=X;
END;
{**************************************************************************}
PROCEDURE READFR(VAR FR:STR4;VAR LEN:INTEGER);
{Reads a frame number from the keyboard.}
VAR
  I:  INTEGER;
  X:  CHAR;
BEGIN
  FOR I:= 0 TO LFR DO
  BEGIN FR[I]:=´ ´;END;

  I:=0;
  REPEAT
     X:=READCHR;
     IF (ORD(X)>=48) AND (ORD(X)<=57) THEN
     BEGIN FR[I]:=X;I:=I+1; END;
  UNTIL (EOLN) OR (I=LFR+1);
  LEN:=I;
END;
  {************************************************************************}
FUNCTION HEXDEC(X:CHAR):INTEGER;
{ Converts hexadecimal character to hexadecimal digit.}
BEGIN
  CASE X OF
   ´0´,´1´,´2´,´3´,´4´,´5´,´6´,´7´,´8´,´9´:HEXDEC:=ORD(X)-48;
   ´A´,´B´,´C´,´D´,´E´,´F´                :HEXDEC:=ORD(X)-55;
  END;
END;
{**************************************************************************}
PROCEDURE FRAMECON (VAR NUMBER:INTEGER);
{ Converts frame number from hexadecimal to decimal.}
VAR
I,C:  INTEGER;
TEMP: PACKED ARRAY[0..3] OF CHAR;
```

Listing 1 continued on page 92

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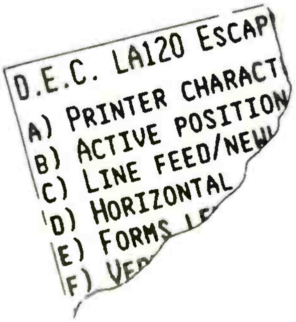

D.E.C. LA120 ESCAP
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D) HORIZONTAL
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Listing 1 continued:

```
BEGIN
  TEMP[3]:=RWS[2];
  TEMP[2]:=RWS[3];
  TEMP[1]:=RWS[0];
  TEMP[0]:=RWS[1];
  NUMBER :=0;

FOR I:= 0 TO 3 DO
    BEGIN
         C:=0;
         CASE I OF
            0: C:=1;
            1: C:=16;
            2: C:=256;
            3: C:=4096;
         END;
    NUMBER:=NUMBER  + C*HEXDEC(TEMP[I]);
    END;
 END;
 {***************************************************************************}
PROCEDURE COMMAND(X:CHAR);FORWARD;
PROCEDURE ERRORCHK;
{ This procedure may be useful for debugging communication problems with UEI.}
BEGIN
    UNITCLEAR(8);
    UNITCLEAR(7);
          RWS:=´     ´;
          TWS:=´EA´;
          UNITWRITE(8,TWS,2);
          UNITWAIT(8);
          WRITELN(´FINICED WRITING´);
          UNITREAD(7,RWS,2);
          UNITWAIT(7);
          WRITELN(´FINISHED READING´,RWS);

          IF RWS[0]=´!´ THEN
             BEGIN
               ERROR[1]:=RWS[1];
               ERROR[2]:=RWS[2];
               WRITELN(´ UEI HAS DETECTED ERROR ´,ERROR,´SEE PAGE 2-16.´);
             END;

 END;
 {***************************************************************************}

PROCEDURE SENDFRAM(FR:STR4;LEN:INTEGER);
{ Converts  frame number to code expected by UEI.}
VAR L : INTEGER;
BEGIN
FOR L:=0 TO LEN-1 DO

     BEGIN
       CASE FR[L] OF
         ´0´:TWS:=´3F´;
         ´1´:TWS:=´0F´;
         ´2´:TWS:=´8F´;
         ´3´:TWS:=´4F´;
         ´4´:TWS:=´2F´;
         ´5´:TWS:=´AF´;
         ´6´:TWS:=´6F´;
         ´7´:TWS:=´1F´;
         ´8´:TWS:=´9F´;
         ´9´:TWS:=´5F´;
       END;
       UNITWRITE(8,TWS,2);
       UNITWAIT(8);
    END;
               {ERRORCHK;}
END;
{****************************************************************************}

PROCEDURE LINK;
{ Initializes communication with UEI.}
BEGIN
WRITELN(´ENTERINBG LINK´);
  UNITCLEAR(8);
  TWS:=´DO´;
  UNITWRITE(8,TWS,2);
  UNITWAIT(8);
  TWS:=´FD´;
  UNITWRITE(8,TWS,2);
  UNITWAIT(8);
```

Listing 1 continued on page 94

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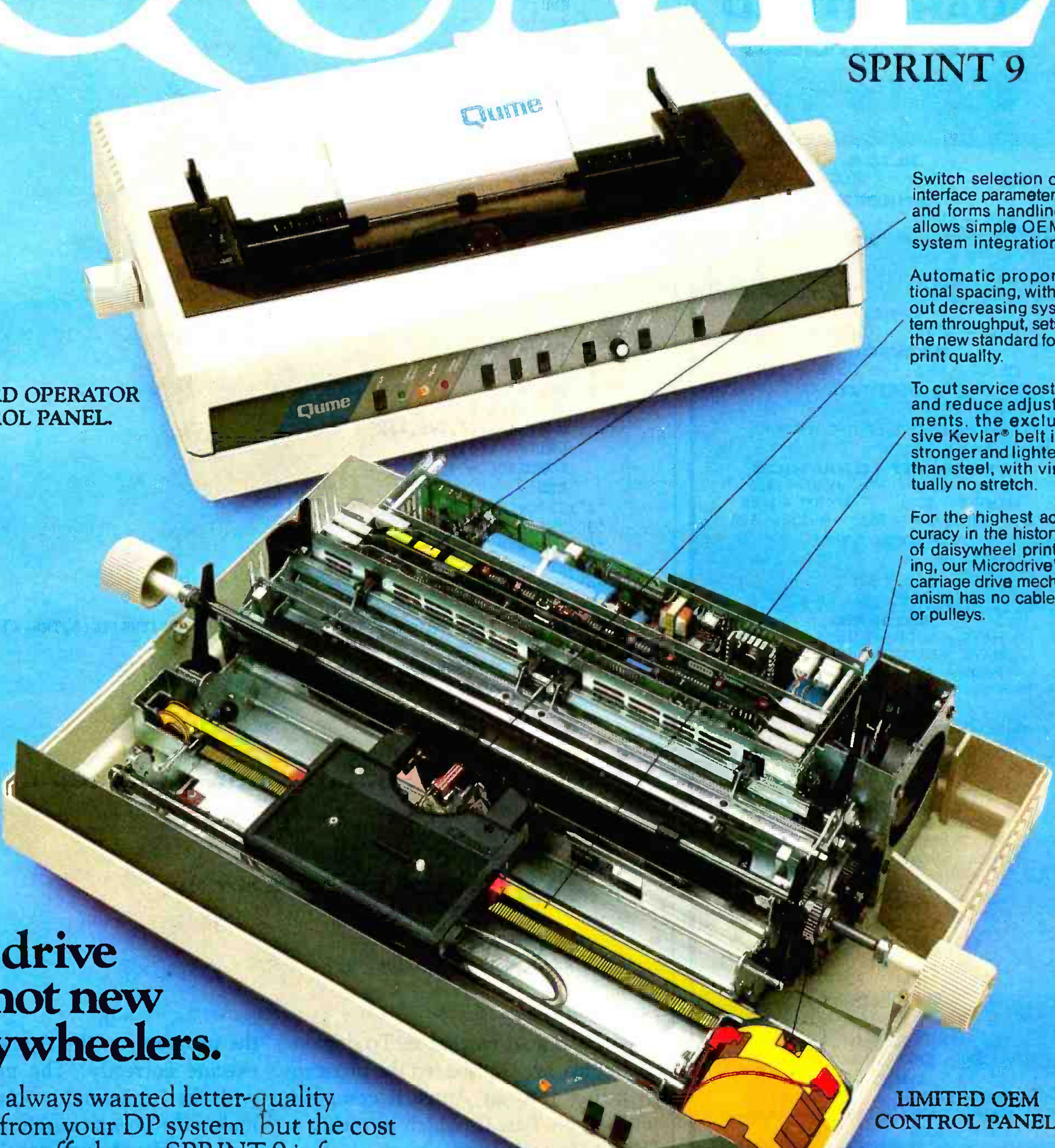
Listing 1 continued:

```
WRITELN(´LEAVING LINK´);
{ERRORCHK;}
END;
{*************************************************************************}

PROCEDURE PRINTMEN;
{ Prints a menu of commands.}

BEGIN
   {WRITELN(CHR(CS)); CLEAR SCREEN}
    WRITELN(´  a RECALL        k  DUMP RAM         u  STEP FWD     ´);
    WRITELN(´  b CLEAR         l  DUMP FRM #       w  SEARCH       ´);
    WRITELN(´  c RUN/BRANCH    m  DUMP PLYR STATUS x  INPUT        ´);
    WRITELN(´  d WRITE PROG    n  END PROG         y  REJECT       ´);
    WRITELN(´  e FRM DSPLY OFF o  DEC REG          z  SLOW REV     ´);
    WRITELN(´  f FRM DSPLY ON  p  FRM DSPLY TOG.   1  STOP         ´);
    WRITELN(´  g AUDIO 2 OFF   q  SLOW FWD         2  AUDIO 2 TOG  ´);
    WRITELN(´  h AUDIO 2 ON    r  AUTO STOP        3  PLAY         ´);
    WRITELN(´  i AUDIO 1 OFF   s  AUDIO 1 TOG      4  STEP REV     ´);
    WRITELN(´  j AUDIO 1 ON    t  STORE            5  LOAD         ´);
   WRITELN(´                9 TO END SESSION                       ´);


END;
{************************************************************************}

PROCEDURE SENDCOMM(X:CHAR);
{ Preprocesses commands to player.}
BEGIN
  CASE X OF

  ´a´,´b´,´c´,´d´,´t´,´x´,´l´: WRITELN(´ COMMAND NOT IMPLEMENTED.´);

  ´e´,´f´,´g´,´h´,´i´,´j´,´k´,´l´,´m´,´n´,´o´,´p´,´s´,´u´,´y´,´2´,´3´,´4´,´5´,
  ´9´:COMMAND(X);

  ´q´,´r´,´w´,´z´:BEGIN
             WRITELN(´ENTER FRAME NUMBER FOLLOWED BY RETURN.´);
             READFR(FRAME,FRLEN);
             WRITELN(´FRAME AND FRLEN ARE´,FRAME,FRLEN);
             SENDFRAM(FRAME,FRLEN);
             COMMAND(X);
             END;


END;

END;
{************************************************************************}
PROCEDURE COMMAND;
{ Translates commad to expected code and tranmits it to .}
 BEGIN
   WRITELN(´ ENTERING COMMAND PROC.´);
   UNITCLEAR(7);UNITCLEAR(8);
   TWS:=´  ´;
   RWS:=´    ´;
   CASE X OF
     ´e´:TWS:=´E3´;
     ´f´:TWS:=´E4´;
     ´g´:TWS:=´E5´;
     ´h´:TWS:=´E6´;
    ´i´:TWS:=´E7´;
    ´j´:TWS:=´E8´;
    ´l´:BEGIN
          TWS:=´EA´;
          UNITWRITE(8,TWS,2);
          UNITWAIT(8);
          UNITREAD(7,RWS,4);
          UNITWAIT(7);
          WRITELN(´THE FRAMENO IS´,RWS);
          FRAMECON(FRAMENO);
          WRITELN(´ THE DECIMAL FRAME NO IS  ´,FRAMENO);
          END;
     ´m´:BEGIN
           TWS:=´EB´;
           UNITWRITE(8,TWS,2);
           UNITWAIT(8);
           UNITREAD(7,RWS,4);
           UNITWAIT(7);
           WRITELN(´THE PLAYER STSTUS IS´, RWS);
           END;
```

Listing 1 continued on page 96

QUME

SPRINT 9



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Listing 1 continued:

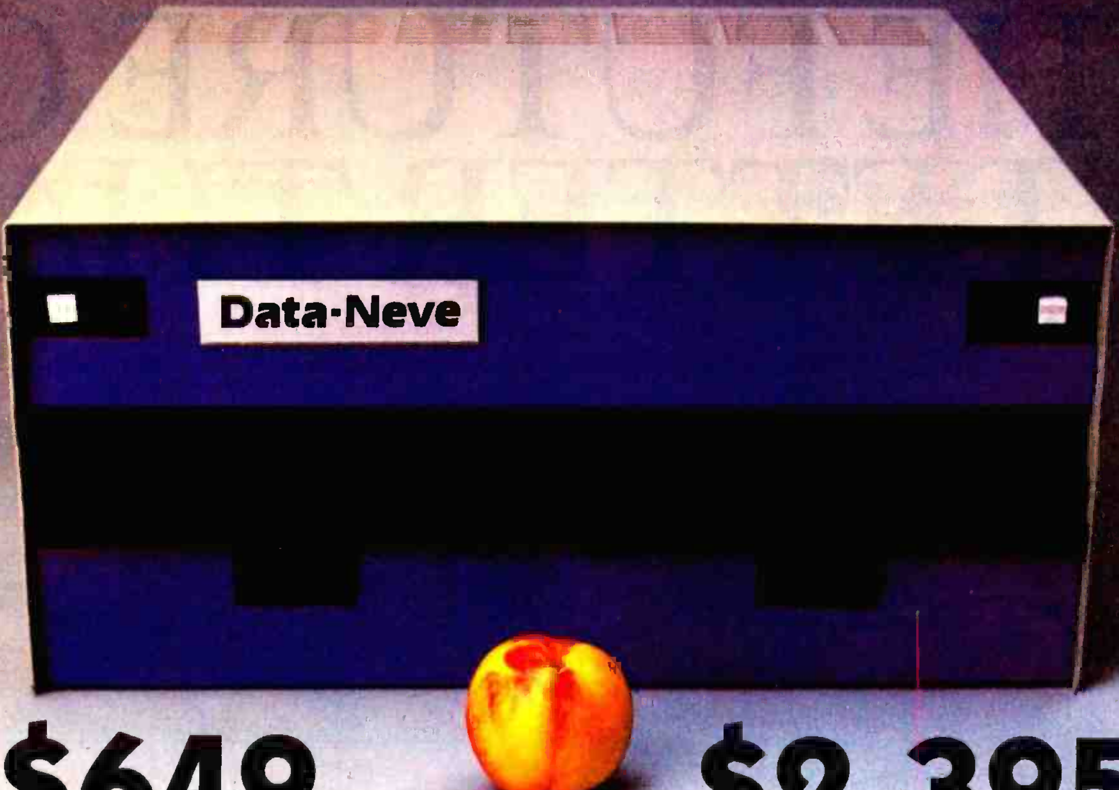
```
     'p':TWS:='F1';
     'q':BEGIN
         TWS:='D3';
         UNITWRITE(8,TWS,2);
         UNITWAIT(8);
         TWS:='F2';
         UNITWRITE(8,TWS,2);
         UNITWAIT(8);
         TWS:='D4';
         UNITWRITE(8,TWS,2);
         UNITWAIT(8);
         END;
     'r':BEGIN
         TWS:='F3';
         UNITWRITE(8,TWS,2);
         UNITWAIT(8);
         END;
     's':TWS:='F4';
     'u':TWS:='F6';
     'w':
         BEGIN
         TWS:='F7';
         UNITWRITE(8,TWS,2);
         REPEAT
           COMMAND('m');
           WRITELN(RWS);
         UNTIL(RWS[1]='7');
         END;
     'x':TWS:='F8';
     'y':TWS:='F9';
     'z':BEGIN
         TWS:='FA';
         UNITWRITE(8,TWS,2);
         UNITWAIT(8);
         COMMAND('m');
         END;
     '2':TWS:='FC';
     '3':TWS:='FD';
     '4':TWS:='FE';
     '5':TWS:='CC';
     '9':TWS:='F9';
     END;
     IF NOT(X IN['1','m','w','q','r','z']) THEN UNITWRITE(8,TWS,2);
     IF X='9' THEN
                 TWS:='D1';
                 UNITWRITE(8,TWS,2);
                 UNITWAIT(8);
                 {ERRORCHK;}

END;
{********************************************************************************}
 BEGIN
 LINK;
    PRINTMEN;
       REPEAT
            WRITELN('ENTER COMMAND FROM MENU.');
            COM:=READCHR;
            SENDCOMM(COM);
       UNTIL COM='9';
    WRITELN(' END OF SESSION.');
END.
```

Text continued from page 90:

makes this goal reachable. To demonstrate this, we transferred the program in listing 1 to an Apple II computer with Apple Pascal (which in reality is UCSD Pascal) and a serial communication card. To do this, I had the program "printed" from the Terak. The Apple on the other end received the file, placed it in a buffer, and upon completion of the transfer, saved it on disk. (I am grateful to Barbara Benton for writing this program.) It almost worked! While I was able to compile the program on the Apple, it did not execute correctly. The problem was with the "unitwait" procedure, which makes the program wait until the port has completed sending the information. The unitwait procedure is not available in the Apple. Therefore, to make the program work, we had to insert an empty loop in lieu of the unitwaits.

What makes this little experiment interesting is that the program uses inputs and outputs rather than just inter-

Ain't that a peach!



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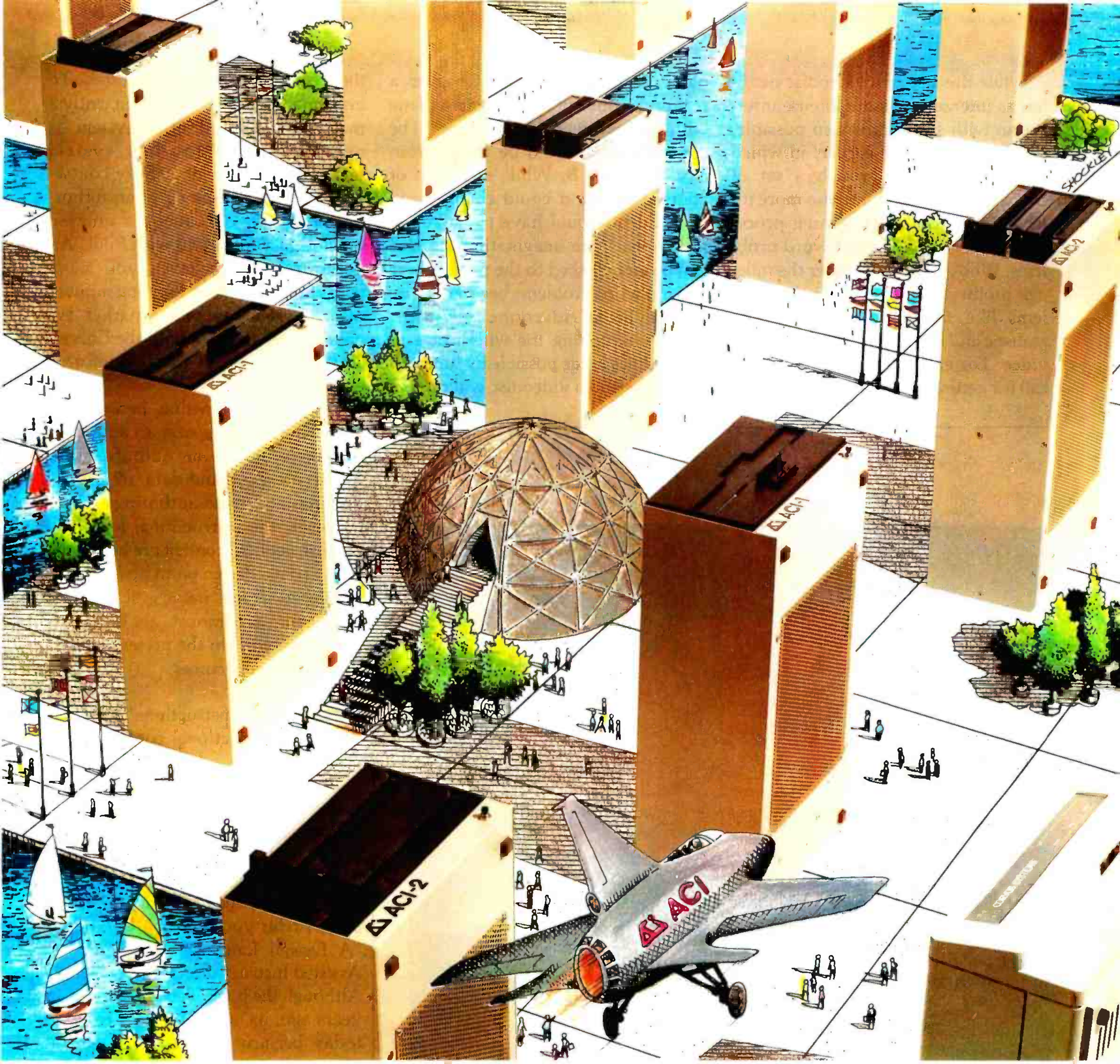
nal computations. I/O (input/output) has traditionally been an area of incompatibility among computers. The fact that a program written on an entirely different computer is capable of running practically unmodified on another computer suggests that the software industry is moving in the right direction toward portable software. Unfortunately, full software transportability requires that not only I/O operation be transportable but graphics as well. Graphics transportability is likely to continue to be a problem for the foreseeable future, but progress is being made (see reference 3).

Courseware Considerations

While hardware is at the heart of integrating the communication and information technologies, the quality of courseware will be the determining factor in whether videodisc technology has a lasting impact on education.

Just as you need to integrate the two technologies at the hardware and software level, there must also be a similar integration at the courseware level if you are to avoid the mistakes of early educational television and computer-based education. You must determine what the unique educational capabilities of the videodisc are and how you can develop materials to exploit those capabilities. In particular, what can you do better with interactive videodiscs than with computers alone?

Perhaps the most elementary application of the videodisc would consist of a series of discrete audiovisual segments. The word *audiovisual* gives you a hint that the videodisc is serving two modalities, vision and hearing, simultaneously. Furthermore, through branching you can choose the most relevant audiovisual segments for a given student and thus tailor instruction to the student. Because the videodisc has two audio tracks, sound can be stored in the second track to be used separately from the visuals. To use this sound without distracting the student with irrelevant visuals, you can overlay a white computer frame on the video. Clearly, this is possible only with systems that have overlay capabilities.



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While this use of a videodisc qualifies as interactive, more intense interaction with students is also possible. The example I gave earlier, in which the student steps through a set of frames, is prototypic of these more intense interactions. This same procedure can be used to enact word problems. Who doesn't remember the mileage problems of grade school? Problems like that can be made more realistic and fun by enacting them with video. For example, a problem could call for getting from city A to city B by plane. The student might be given a certain amount of money and a plane with certain flying characteristics. The student's task would be to get from city A to city B. While en route, of course, the wind could change, and the student would have to make adjustments. With imagination the idea can be embellished to the point where solving word problems becomes more like playing an Adventure-type game.

Fully exploiting the wide range of possibilities made possible by linking a computer and a videodisc will require the creativity of many individuals. To implement that creativity efficiently a mechanism, an authoring system, is needed. An authoring system facilitates the development of courseware. Pilot is an example of an authoring *language*. But there is only so much that you can do with Pilot. An authoring *system* gives you more capabilities. In fact, a growing number of such systems are on the market. We have chosen to work with the University of Utah's VCIS as indicated earlier.

The basic distinction between an authoring language and an authoring system is that in an authoring language, the logic and data are part of the program. In an authoring system, however, the instructional logic and the instructional content are kept separate. From a design point of view, this is most desirable because it parallels the dictum: program = algorithm + data structures. In the present context that equation becomes:

Lesson = instructional logic
+ instructional content

An increasing number of authoring systems are being offered, but little guidance as to how to choose one exists. A framework for comparing and evaluating authoring systems is beyond the scope of this article. However, I refer you to Ralph E. Grubb's "A Design Language for Computer Assisted Instruction" (see reference 4). Although the pamphlet was written 10 years ago, its content is very relevant today because it deals with general issues of design rather than specific implementations.

One important variable of any authoring system is the nature of interactions it supports. The University of Utah VCIS supports the interactions we contemplated using and, in principle, allows limited simulations with video tape, which is important because videodiscs are expensive to master and changes cannot be made except by remastering.

The University of Utah's authoring system consists of a series of Pascal programs and some utilities as well. It is, to say the least, a bit overwhelming at first. The authoring process en-

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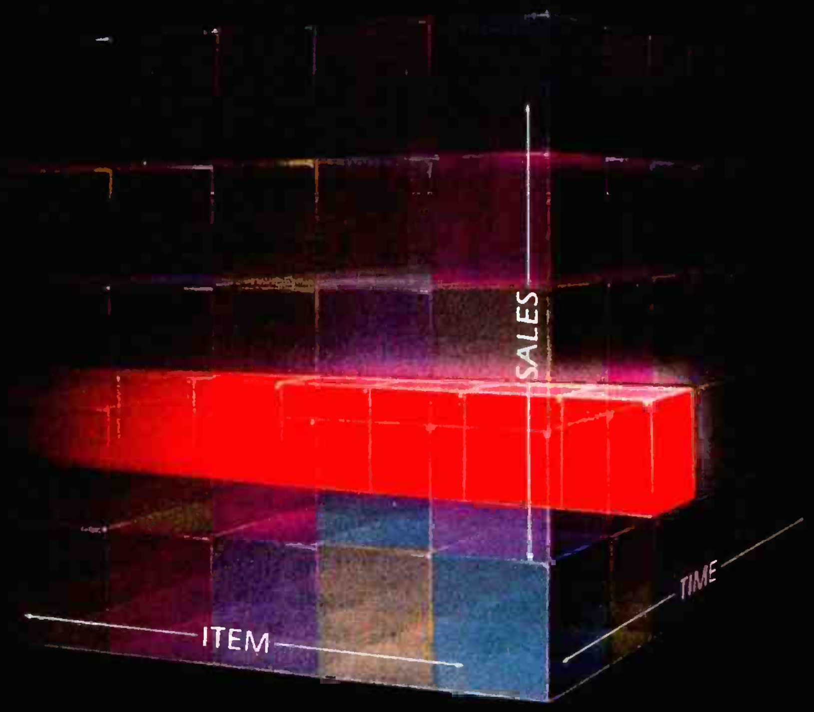

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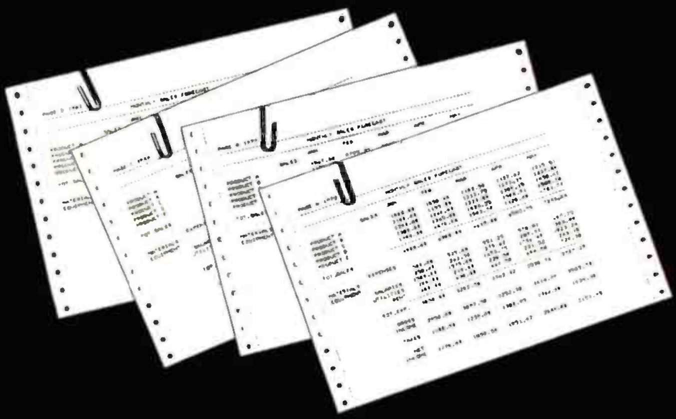

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couraged by the system is to create the content material with the help of the text, graphics, and animation editors. You then use the program Builder to establish the ordering presentation of these materials as well as parameters related to student responses.

While the standard features of the system allow the design of a large variety of instructional designs, the VCIS developers were not so pretentious as to think they had included all the possibilities in the system. You can incorporate features into the system through what they call "specials," a Pascal segment written by users to add a feature peculiar to their applications. The most common application of specials is to design dynamic graphics. For example, if the lesson calls for plotting the graph of an equation to be provided by the student, you need a special to parse the student's equation and then plot the results.

Conclusions

The emphasis on technical issues in this article should not be taken to mean that nontechnical issues are unimportant. Education will continue to be for the foreseeable future an activity in which machines can have only a very limited role, and nontechnical issues are the order of the day. Nevertheless, I would like to think that technology, if intelligently used, can make the ideal of equal educational opportunity a little bit more reachable by making richer educational experiences accessible to a larger number of students. Videodisc technology has the potential of contributing to that goal. ■

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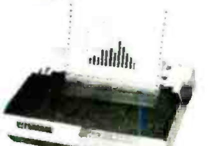

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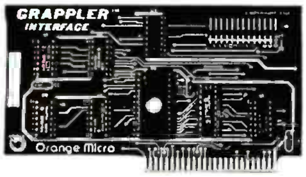

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Cardiopulmonary resuscitation (CPR), when properly performed, is a technique that can save thousands of lives. Existing programs have successfully trained many individuals in the practice, but such programs have been *limited* by the number of qualified instructors available. If an effective, low-cost alternative to live instruction could be found to expand the programs, many more lives could be saved. The advanced state of videodisc technology suggested that a training system might be developed by interfacing a videodisc machine with a personal computer.

Despite recent progress in making computer systems and software easier to use, many people remain computer-shy. Any computer that is less than "ultrafriendly"—totally accommodating and transparent (in the sense of allowing someone to benefit from the system without having to learn how to operate it)—will frighten such people away. A systems designer can't expect them to voluntarily approach a computer's keyboard to find out how easy the computer is to use. Even an occasional pressing of the Return key is too much to ask.

The design of a transparent computer system is difficult, however, and the more complex the functions that the system must perform, the harder it is to keep the interface with the user simple and accommodating. Before attempting to create an ultrafriendly system it is wise to ask whether the project is really important enough to merit the effort involved.

In the case of the American Heart Association's program to teach CPR techniques, many thousands of lives are at stake. Some 500,000 victims each year die before emergency care arrives: children jolted nearly to death by contact with high-voltage wires, businessmen collapsed on the street, football players whose hearts have stopped after vicious tackles, fathers stricken while shoveling snow, and many other ordinary people felled in ordinary surroundings.

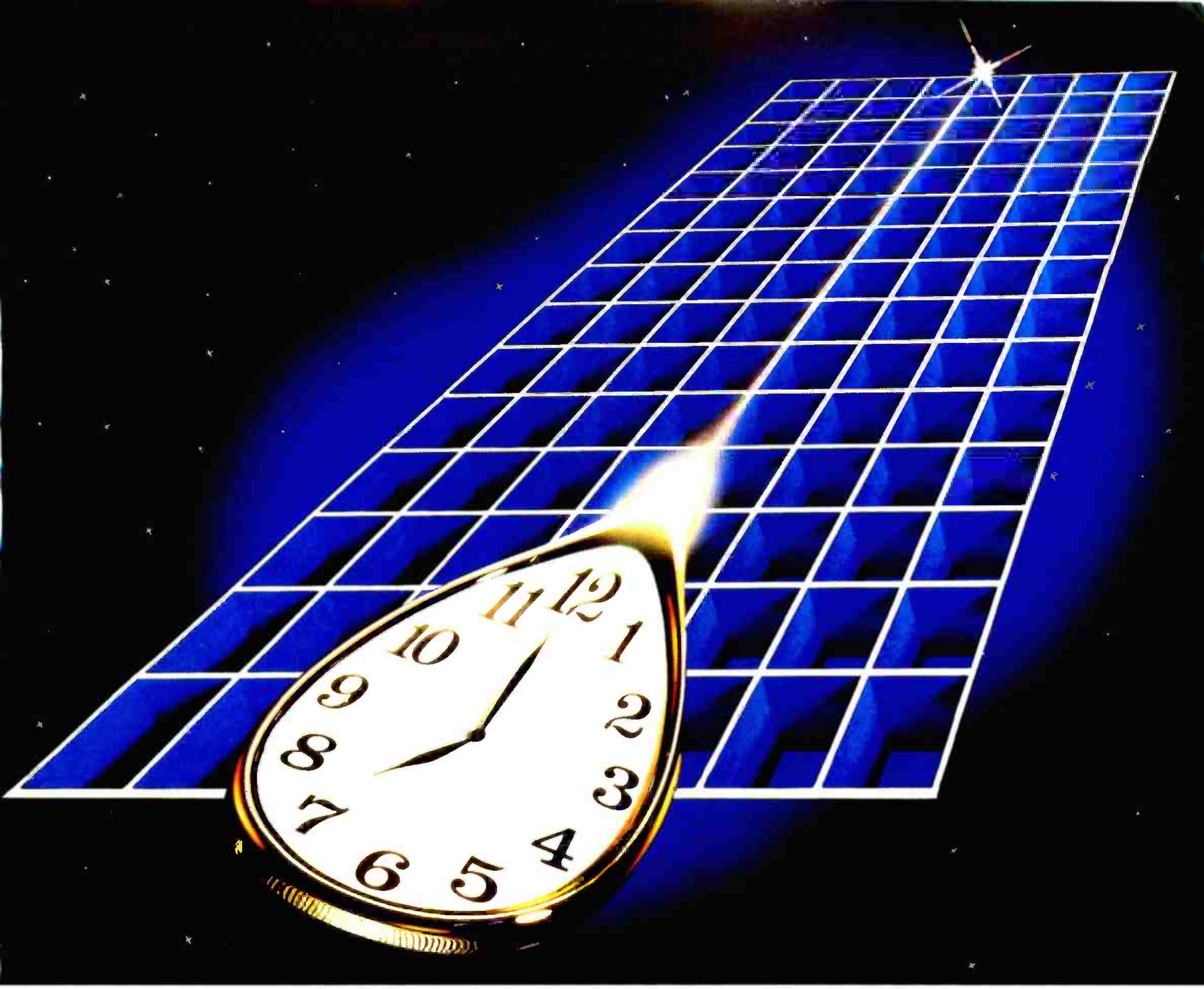
The mechanism of death from a heart attack is well known. Heart failure cuts off the flow of oxygenated blood to the brain. Brain cells begin to die from lack of oxygen. The medical world agrees that a high proportion of heart-attack victims might be saved if life could somehow be sustained for even a few minutes until emergency care arrives.

A Plateau in Lifesaving

But it seemed as if we had reached a plateau in the number of people to whom we could teach the lifesaving techniques of CPR. It seemed as if the number of instructors at any one time remained almost constant. Each year the number of newly trained instructors would continually be offset by the number of previous instructors who let their skills slip away. The plateau was at the level of about 12 million trained rescuers. That made the odds facing a stricken American about 18 to 1 *against* having a competent CPR rescuer present to sustain life during those grim minutes before the arrival of emergency care. Improving the survival odds even one or two percentage points could save tens of thousands of lives.

Human and organizational limits established the plateau in the number of trained rescuers. Expanding the training program through volunteers or paid instructors would always multiply logistics and personnel problems, strain finances, and increase the difficulty of standardizing live instruction.

On the other hand, conventional training media had failed to do much more than present information.



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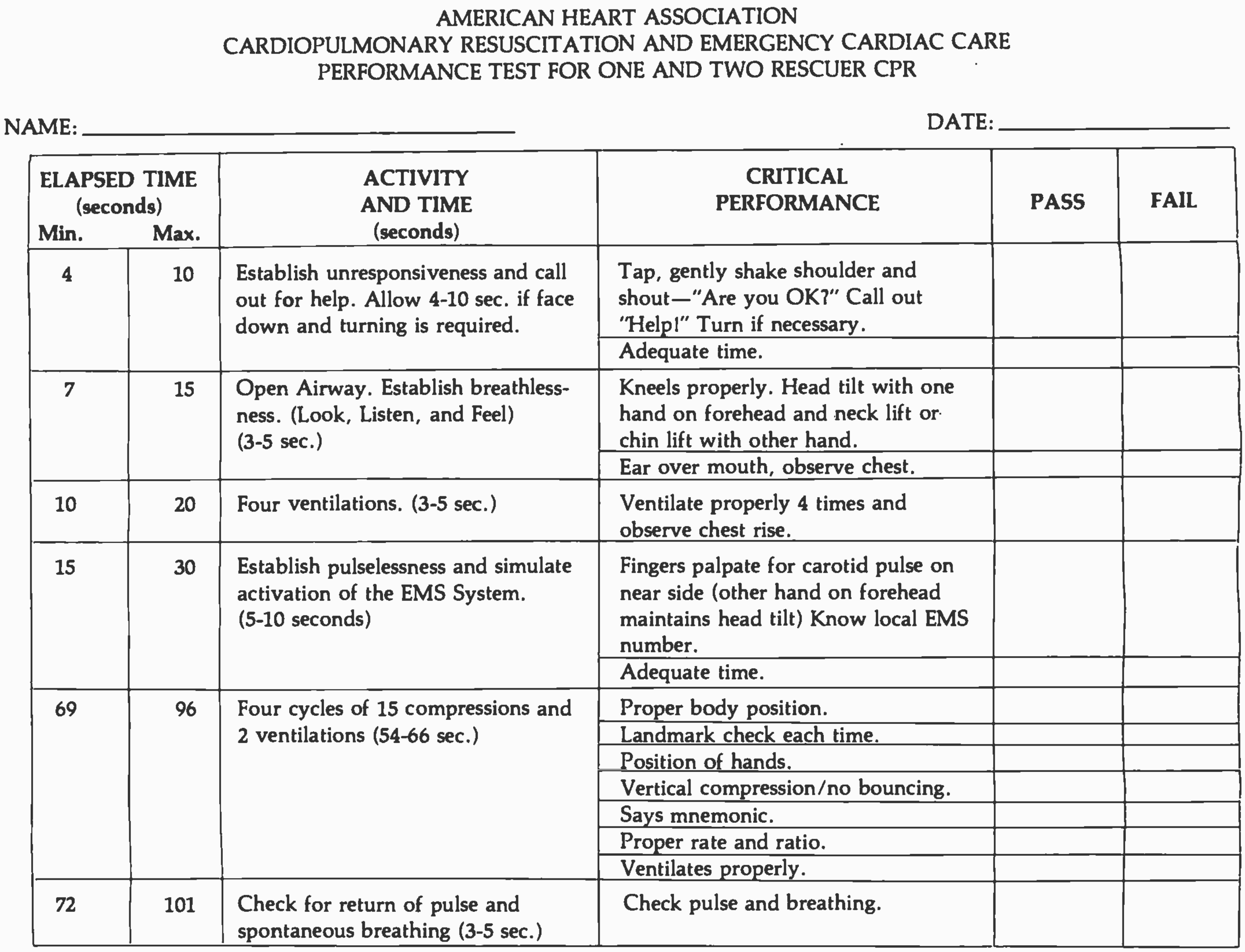

AMERICAN HEART ASSOCIATION
CARDIOPULMONARY RESUSCITATION AND EMERGENCY CARDIAC CARE
PERFORMANCE TEST FOR ONE AND TWO RESCUER CPR

NAME: ____________________ DATE: ____________

ELAPSED TIME (seconds) Min.	Max.	ACTIVITY AND TIME (seconds)	CRITICAL PERFORMANCE	PASS	FAIL
4	10	Establish unresponsiveness and call out for help. Allow 4-10 sec. if face down and turning is required.	Tap, gently shake shoulder and shout—"Are you OK?" Call out "Help!" Turn if necessary.		
			Adequate time.		
7	15	Open Airway. Establish breathlessness. (Look, Listen, and Feel) (3-5 sec.)	Kneels properly. Head tilt with one hand on forehead and neck lift or chin lift with other hand.		
			Ear over mouth, observe chest.		
10	20	Four ventilations. (3-5 sec.)	Ventilate properly 4 times and observe chest rise.		
15	30	Establish pulselessness and simulate activation of the EMS System. (5-10 seconds)	Fingers palpate for carotid pulse on near side (other hand on forehead maintains head tilt) Know local EMS number.		
			Adequate time.		
69	96	Four cycles of 15 compressions and 2 ventilations (54-66 sec.)	Proper body position.		
			Landmark check each time.		
			Position of hands.		
			Vertical compression/no bouncing.		
			Says mnemonic.		
			Proper rate and ratio.		
			Ventilates properly.		
72	101	Check for return of pulse and spontaneous breathing (3-5 sec.)	Check pulse and breathing.		

Figure 1: *A reproduction of part of the American Heart Association's performance test for cardiopulmonary resuscitation by a single rescuer. The CPR training system had to meet the performance standards shown.*

When the subject being taught is a hands-on skill requiring the exercise of judgment, merely presenting information isn't good enough. As a result, slides, tapes, films, and printed matter could do no more than assist a live instructor.

Finding a Technological Solution

Could a computer-based, instructorless system succeed where human teachers and conventional aids had failed? The human instructor begins by giving basic instructions to the student, who then experiments with a *training* manikin. The process is one-on-one coaching through repeated drills. The live instructor gives the student constant attention, commentary, and evaluation as the student works on the manikin. Often the student needs to receive instructions while keeping his or her eyes fixed on the manikin.

To replace the human instructor, then, a computer-based system had to meet a long list of general requirements. First, it should provide total, stand-alone interactivity with students. It should train people to meet the certification standards in the American Heart Association's Cardiopulmonary Resuscitation and Emergency Cardiac Care Performance Test (see figure 1). It must meet or exceed the results of live instruction at every comparison and should provide high standardization and limited need for personnel and logistics. The system should teach basic concepts as well as hands-on skills and be able to instruct the student at times without requiring the student to take his or her eyes off the manikin (in other words, coach the student aloud). The entire setup should cost the agencies that would be the end users something under $15,000. And finally, it should be accommodating, responsive, and as easy for the average person to operate as an arcade game.

These last two requirements were essential to achieving the kind of broad outreach in CPR training that the American Heart Association wanted to encourage. The rough figure of under $15,000 as the retail price of all hardware and software would make the system affordable for those institutions that wanted to expand CPR programs but could not

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Photo 1: *The complete CPR training system. The Sony LDP-1000 videodisc, normally out of sight, appears in the foreground. Author David Hon is trying to revive the electronic manikin. The video screen at left shows the doctor, who is coaching Hon from the videodisc. The computer video screen at right, which the doctor refers to as "Compy," is showing a graphic analysis of chest compressions as Hon performs them. The Apple II computer, which manages the system, is concealed behind the drapes below the video screen at right. (Photo by Jim Sheldon.)*

justify the personnel or logistical costs of hiring more instructors.

We felt that the requirements of transparency and simplicity were as important as any of the others. We didn't believe that an instructional system that required students to develop skill in using a computer could succeed. We had learned something from games like Space Invaders: if you design a computer-based system in such a way that people know the difference between winning and losing, virtually anyone will jump in and try to win. Saving a life is a big victory and a big incentive. We were sure that if we could build a system that was easy to use and engaging, trainees would use it and learn from it willingly.

We also knew that the project wouldn't be easy. But the prospect of training thousands of people and saving thousands of lives justified the effort required. In that context, we didn't have the luxury of that technical snobbery that says, "There's no sense wasting time on people who can't learn to use our computers."

In short, we needed a combination of hardware, software, and online data that would answer questions on request, instantaneously gather information about each student's hands-on performance, respond to each action with appropriate spoken instructions or video demonstrations, gather data on the student's next attempt, respond with appropriate instructions or demonstrations, and so on, until the student performed up to standards—without needing to know anything about how to use a computer. We needed a more-than-friendly "total coaching loop" for under $15,000.

We seem to have achieved our goals. Photo 1 shows the finished system in use. But there's much more to the story than any photograph can show. I hope that the following description of the development of the CPR training system will encourage others to undertake similar projects with videodisc technology.

Working Toward a Design

Reflection on our general requirements soon led us to a list of more specific requirements with clear implications for hardware and software design.

Meeting the performance standards for certification of millions of ordinary people who learn in different ways would take a large, comprehensive set of visual segments, both still and moving. We rejected the use of video tape because of its slow response time and its lack of first-rate freeze-frame capabilities. Videodisc technology seemed the only possibility for storage and rapid retrieval of the number of segments required.

We had to be able to retrieve instantly from storage the *right* video segments for each action of each student during training. This required, besides storage on videodisc, evaluation and management by computer. The computer would have to assess students' efforts, draw appropriate coaching from storage, reassess efforts and supply appropriate coaching again and again, and provide a final evaluation of each student's performance. To achieve the necessary speed, we would have to do extensive machine-language programming.

We also had to face the fact that making software for a video display automatically makes you a television producer, with all the associated privileges and responsibilities. As a former television script writer, I saw that one of the greatest challenges of this project was creating a script that embodied a system design and had a format that three unrelated groups could work with: medical experts, video producers, and computer programmers. (I'll say more on this later.)

We also needed a large set of audio segments. Some of these would talk along with videodisc freeze frames, explaining the material shown in the still illustrations. Consequently, the speed of audio access had to match the speed of retrieval from the videodisc. The videodisc can record sound and play it back, but you can only get voice off the disc when the disc is running (i. e., not during a still frame). Therefore, whenever the voice accompanies a still picture (appearing unchanged in successive video frames), you are wasting frames. You waste about 400 video frames for every 15 seconds of still picture.

Since we didn't want the user or anyone else to have to change videodiscs, we had to squeeze a great deal onto a single disc. Rather than waste videodisc space on sound to accompany freeze frames, we decided to use another audio device of some kind for that purpose. Investigation of voice synthesizers showed that they would prove too expensive for the end user and too artificial in tone to achieve the kind of friendliness that we wanted. The remaining choice was an audio recorder. But ordinary sequential-access audio recorders were out of the question. We needed a random-access audio recorder to match the speed of the random-access videodisc. Unfortunately, there was no such thing as a random-access audio recorder. We would have to create one.

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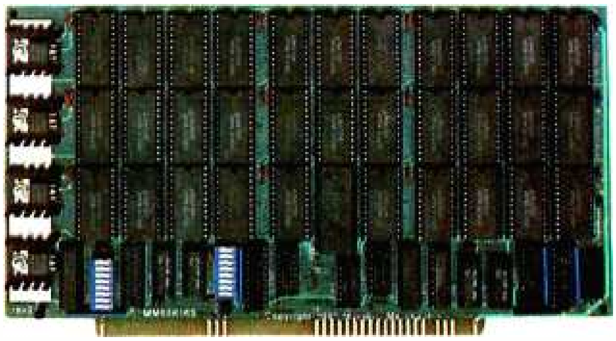

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To measure students' performance in the hands-on skills of CPR, we would have to install a number of different sensors in the training manikin. The sensors would be peripheral input devices to the microcomputer. The manikin would "feel" certain combinations of actions and feed resultant data into the microcomputer for instant evaluation, and the microcomputer would then call up one of the hundreds of branches available to coach the learner. Because no sensory peripherals existed that were appropriate for measuring student actions and sending data to the computer, the hardware would have to be designed in parallel with and after the software. Since the peripherals were yet to be designed, we needed a computer that permitted the flexibility of adding cards later to interface with the peripherals. We chose the Apple II because of its open structure.

The data supplied by the sensors would enable the system to talk along while the student was working on the manikin. With chest compression, for example, the system would say things like, "Find the notch on the sternum," or, "Do one compression. . . . I'll give a low tone when you're close and a high tone for exactly right." To coach the student to apply the right pressure, the on-screen instructor would say "a little more gently this time," or "too deep," or "keep trying till you get a high tone."

As for transparency and simplicity, although we didn't want trainees to see the computer or its keyboard, we felt that interaction with a video screen would be all right. The television has become such a fixture of contemporary life that the screen seems anything but menacing to most people. People are accustomed to having control over television, and as the name "boob tube" makes plain, the television seldom displays anything resembling enough intelligence to pose a threat.

We decided to let trainees interact with the computer by using a light pen on the computer video screen. The light pen alone would enable trainees to learn the basic vocabulary

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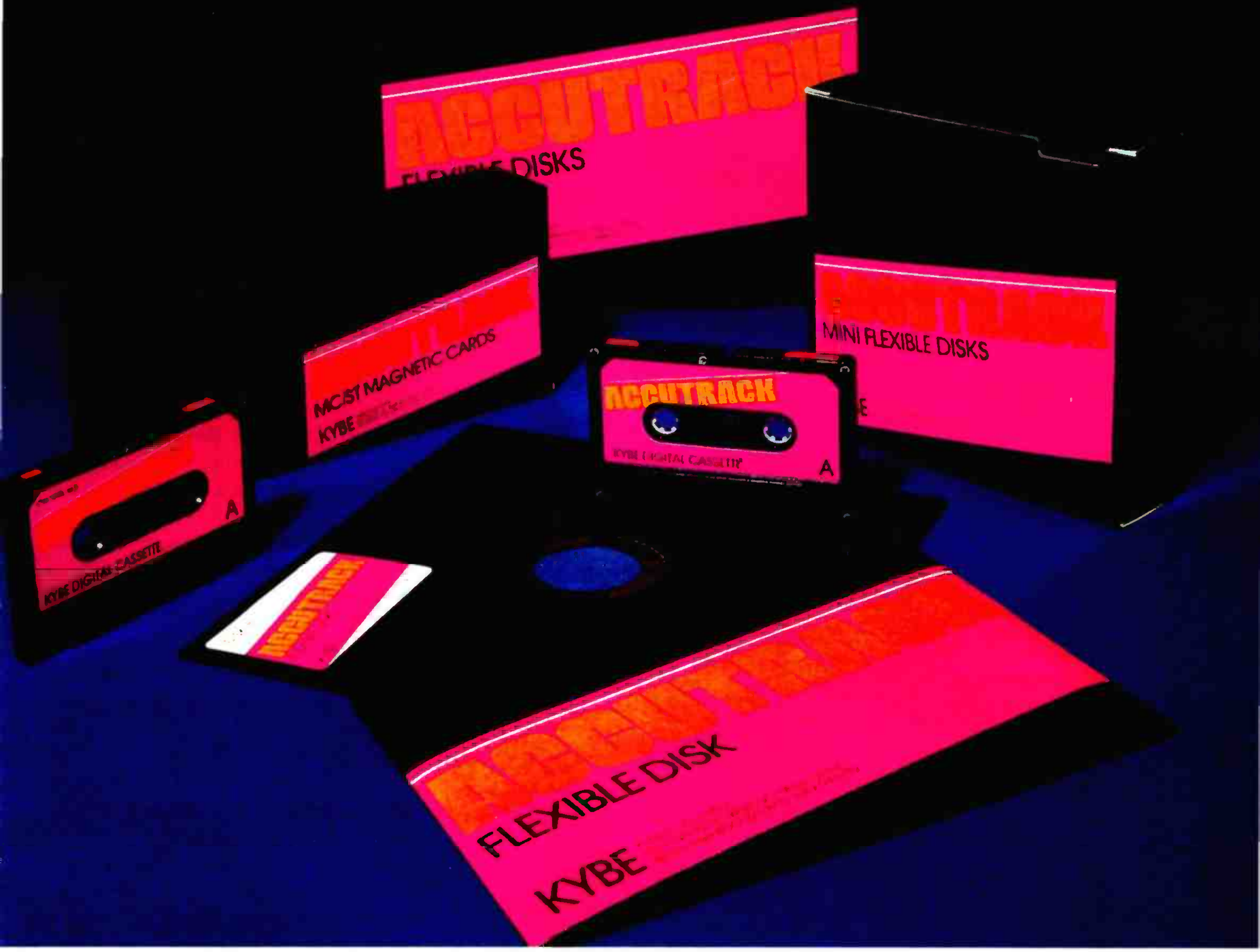

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and concepts of CPR. We would have to provide a way for the video screen to perform some of the functions normally handled by a keyboard.

The Prototype

Now all we had to do was find the right videodisc, produce thousands of video images, develop a random-access audio recorder, record numerous audio segments, write software to permit hundreds of different instructional branches of both sound and images in such a way as to reflect medical expertise in each simple response to every move by the student, and then arrange for the microcomputer to read the sensors in the manikin and the light pen on the video screen, control the audio recorder and the videodisc player, and integrate all this in a single high-speed system. As we sat down to design the prototype, we knew that it wouldn't be easy.

To make the building of the initial prototype more manageable, we decided to limit its instructional range to a single hands-on skill. CPR involves opening the victim's airway, ventilating the victim (giving mouth-to-mouth resuscitation), and performing external chest compression. Because the prototype had to convince people of the system's value, we wanted to teach the most difficult of these skills. This is external chest compression, which requires controlling three different parameters: placement of the hands, depth of action, and rhythm. We felt that if we could demonstrate that the system could successfully coach external chest compression, we could do everything else. We would consider the prototype a success if it coached 95 percent of its students to a high level of performance.

Rather than give separate and sometimes overlapping accounts of the development of the prototype and the later development of a full, multifunctional system, I will just say here that the prototype was successful enough to make people see the real possibilities of the videodisc-based system. The first demonstration of the prototype was in November 1980 to 65 physicians in a back room of the Miami Convention Hall where the American Heart Association was holding its Annual Assembly. Those in attendance showed enthusiasm for the project, provided we could manage to teach *all* the CPR skills.

The American Heart Association's Emergency Cardiac Care Subcommittee saw the potential in the system; however, it said that to be really effective as a training tool, the manikin would have to respond not only to compressions and ventilations but also to a whole range of techniques that are simple for a teacher to evaluate but had never before been simulated or evaluated by a computer.

Meeting this challenge would demand real sophistication. The flow of CPR requires first shaking the victim to see if he or she can be awakened, calling out for help, rolling the victim on his or her back if necessary, then getting the victim's airway open, and then looking, listening, and feeling for spontaneous breathing. The manikin would have to be able to tell

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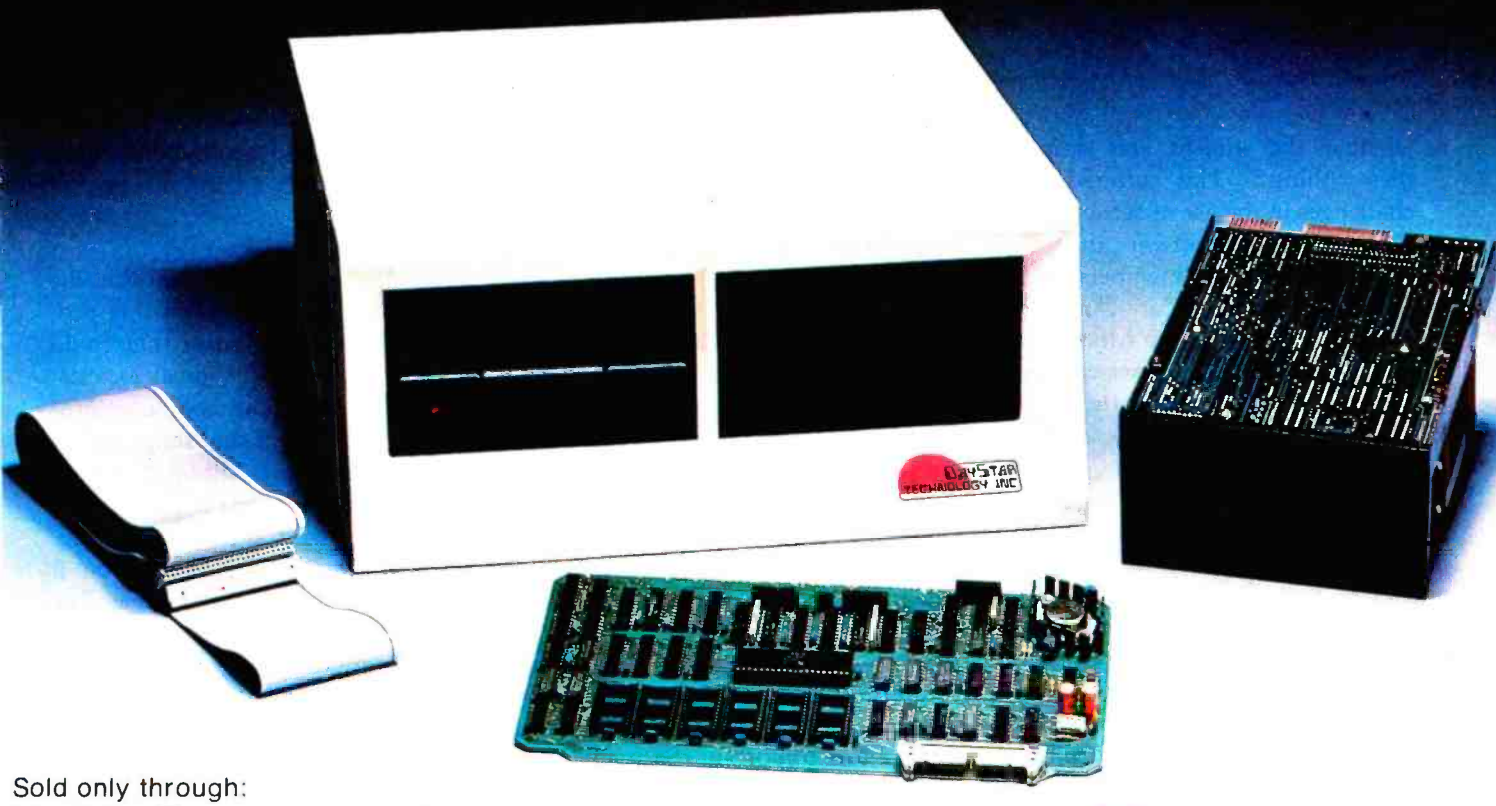

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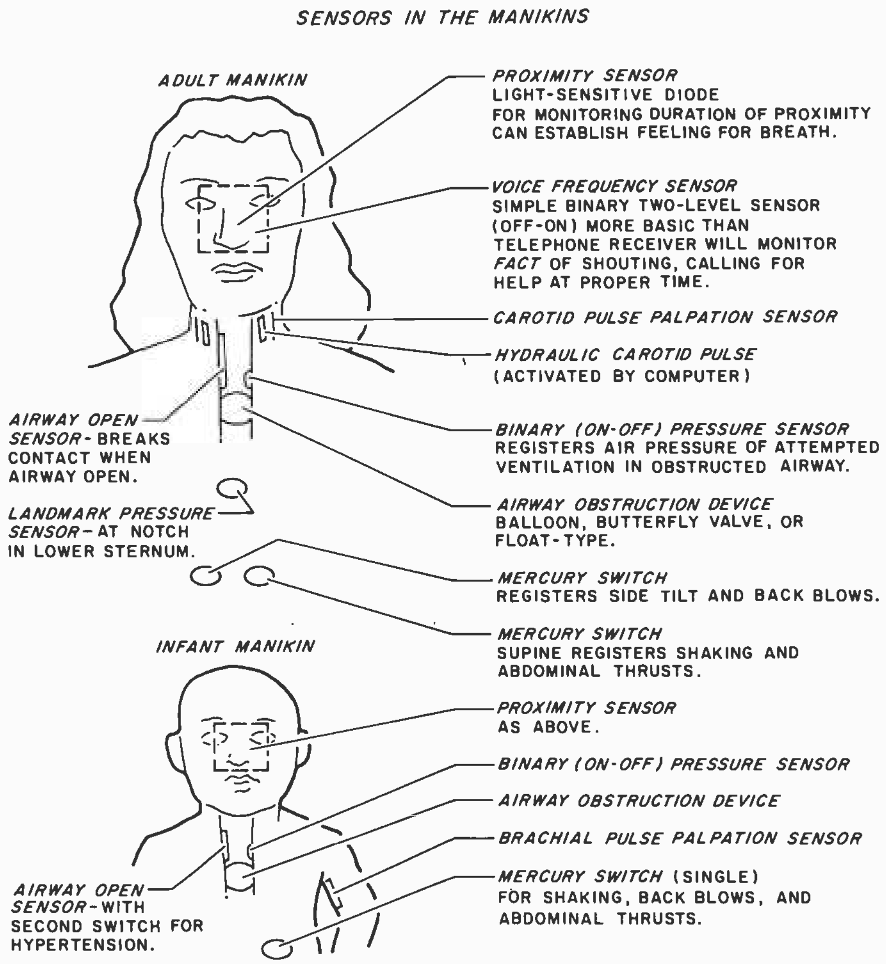

Figure 2: *The placement and types of sensors in the adult and infant training manikins.*

whether the student was doing all these things. This offered more challenges in the use of sensors and in writing complex software than I had planned. But the members of the Emergency Cardiac Care Committee, especially Drs. William Montgomery and William F. Kaye, set the goals. As a result of their demands and their efforts in reviewing my drafts of scripts for the videodisc, the full system is much better and more comprehensive than it would otherwise have been.

Now let's take a look at what was required to develop the full system.

Help with Equipment

Finding the right video equipment for the project was difficult. No video-tape recorder could achieve the *nearly* instantaneous response to a student's actions, as measured by sensors in the manikin, that was essential to the success of the coaching loop. Video-tape recorders also lack the ability to provide freeze frames of high quality. Even a home optical videodisc player would have required several seconds to react to the student's actions.

We approached a number of companies about videodiscs with greater capabilities. Few would talk to us. Only Sony was willing to cooperate in the project. Sony offered both technical and financial support. Ted Sato, Sony's chief videodisc engineer in the United States, and Dan Harris, manager of new-product development for Sony Video Products, were invaluable in supplying videodisc players, videodisc pressing, video monitors, and assistance in putting the first two sensors in the manikin. Even more important, Sato and Harris provided the kind of psychological support that difficult, innovative projects need even more than money and equipment.

The Sony videodisc player, an industrial model LDP-1000, has its own built-in microprocessor for very fast access to video frames. The LDP-1000 and a videodisc are visible in photo 1. The LDP-1000 is a laser optical videodisc whose advanced features can give the student almost instant feedback. The machine also has a connector and a switch on the back to shift control to an external processor.

Laerdal Medical Corporation also generously helped the project by supplying some of its Resusci-Annie teaching manikins.

Because work on the entire system had to proceed in parallel, the people responsible for giving computer life to the manikins—Jerry Poplin and Bob Soltysik—developed a box to simulate the manikin to the computer and a box to simulate the computer to the manikin.

Figure 2 shows how complex the manikins, both adult and infant, became after the Emergency Cardiac Care Committee broadened our goals. Photo 2 provides a peek inside the infant manikin. Poplin and Soltysik spent late nights performing difficult surgery to equip the manikins as needed. Some of the sensors came from burglar-alarm catalogs, and others, like the airway that blocks on computer command, were sheer invention.

The Script

As noted earlier, I thought that the single greatest challenge in this project was creating a script that could serve the needs of medical experts, video producers, and computer programmers. This unusual script wasn't really a flow chart, although we did sometimes have to make flow charts and then convert them to scripting. The script wasn't a storyboard, but it did have to do the work of one. The script wasn't a simple rendering of content either.

It took five drafts, each in excess of 100 pages, to achieve a workable script. Drs. Montgomery and Kaye contributed greatly by reviewing each of these drafts.

Part of the challenge of writing the script was in developing a sense of what various interactions would look and feel like while the videodisc was

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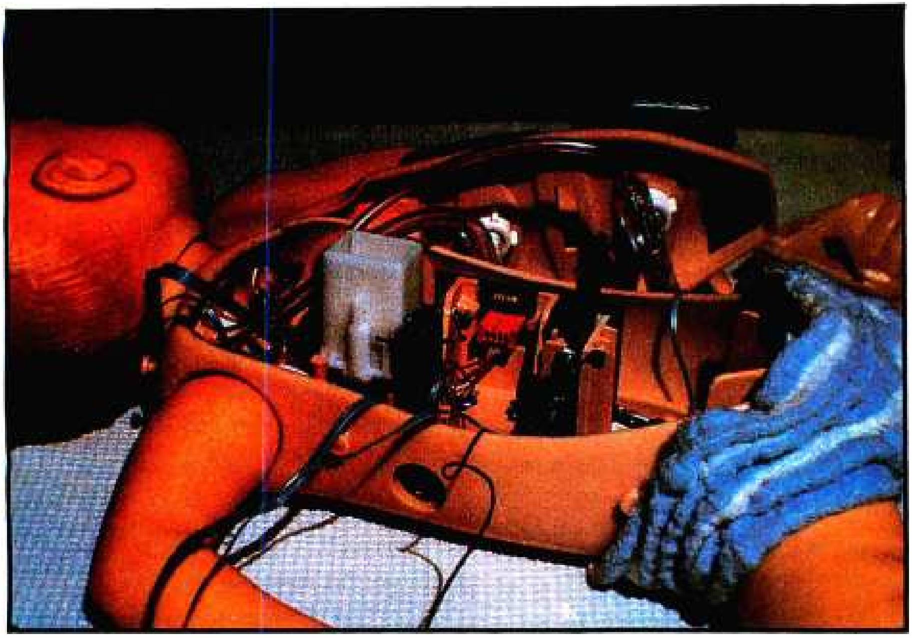


Photo 2: *A peek inside the infant training manikin. Trainees never see the complex of sensors exposed here. (Photo by Jerry Poplin.)*

being produced, three to six months before much of the programming would begin. It is much to the credit of Jane Sallis and Associates in Dallas, the producer of the videodisc, and Gay Hampton, the production assistant, that the final shooting script resulted in a full and effective use of the random-access videodisc and audio-tape systems. The text box below shows a small excerpt from the script.

Software

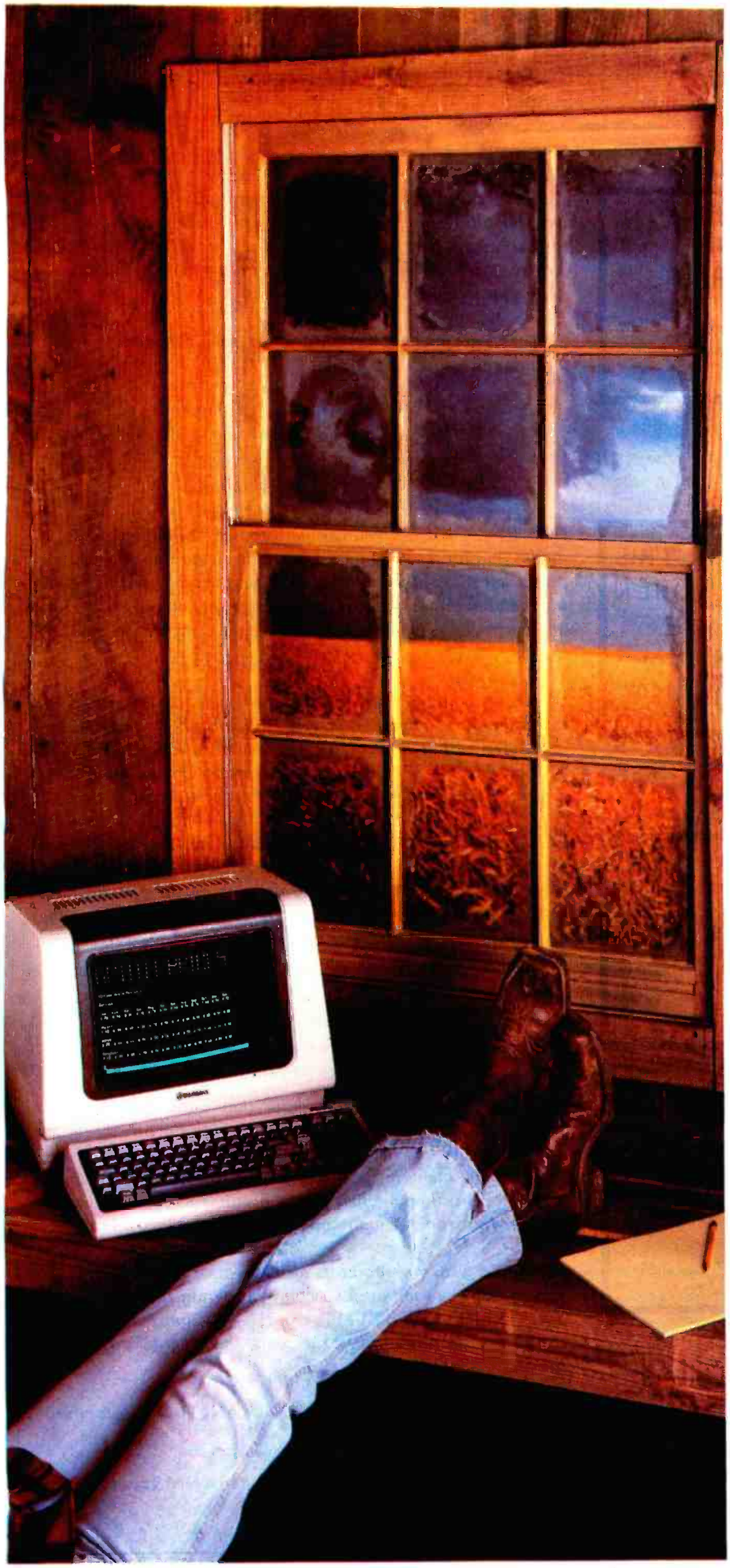
We were fortunate to have two excellent programmers working on the CPR project: Bob Sander-Cederlof and Mike Laumer. Bob is the president of S/C Software and author of S/C Assembler II and S/C Macro, bestselling assemblers for the Apple. Mike has written Flash!, what I understand is one of the best compilers for the Apple. Together they produced some 900 pages of assembly-language programming and a couple of Applesoft BASIC routines.

It was the software that brought the 700 video branches to life. (On this, Mike had some assistance from Bobby Deen, an Apple club member who was still a high school student.) To say the least, the programming task was demanding. The easy part was the 150 pages of text for quizzes and answers. The programmers had to make the videodisc operate in response to light-pen choices with "any time" interrupts. There were also interrupts for the 20 analog and digital systems in the manikin.

Text continued on page 130

The Script for the Interactive Training System

TV Monitor	Computer Monitor	Script
ILLUSTRATION MATCH DRAWING TO SLIDE	BLANK	*COMPY (SO) V/O: All right. . . . In the position your friend is lying in, the muscles of the jaw relax and the base of the tongue falls back blocking the airway, which makes it difficult, if not impossible, for air to get through to his lungs . . . Let me show you what I mean. . . .* *(Video screen goes to next illustration, computer screen is blank)*
ILLUSTRATION BENT AIRWAY (MATCH WITH PREVIOUS ILLUSTRATION)	BLANK	*COMPY (SO) V/O: See how the flow of the air to the lungs is being blocked?* *(Video screen goes to next illustration, computer screen is blank)*



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TV Monitor	Computer Monitor	Script
ILLUSTRATION BENT AIRWAY and STRAIGHT AIRWAY	BLANK	*COMPY (SO) V/O: So what you'll need to do is open that airway by tilting his head back. . . . This pulls the base of the tongue away from the back of the throat and opens the airway . . . We'll show you two ways to do that, and then we'll want you to try them on the manikin. . . .* *(Video screen goes to next illustration, computer screen goes to "Touch this spot. . . ." display)*
ILLUSTRATION STUDENT AND MANIKIN IN FRONT OF SCREENS	TOUCH THIS SPOT WHEN YOU ARE READY TO BEGIN ▨	*COMPY (SO) V/O: You can perform CPR on either side of a victim, but for teaching purposes, we'll always have the rescuer on the left side of the manikin. Now kneel down like this beside the manikin and make sure you can see the screen. We'll wait, and when you're ready to begin, touch the computer screen with the light pen. . . .* *(When the computer screen is touched, video screen goes to illustration and computer screen is blank. If no response is monitored within 20 seconds, program reroutes to* HAVE YOU TRIED THAT YET? BRANCH *— Generic/Compy with video screen holding image of student in front of screens)*
ILLUSTRATION HEAD-TILT/ CHIN-LIFT (MATCH WITH NEXT SLIDE)	BLANK	*COMPY (SO) V/O: Good. . . . Okay, now, the first method for opening the airway is the head-tilt/chin-lift. Notice that one hand is tilting the head back by pressing on the victim's forehead, while the other hand, using three fingers, lifts up on the nearest side of the chin. The lower lip may also need to be held open with the thumb.* *(Video screen goes to matched slide, computer screen is blank)*
SLIDE HEAD-TILT/ CHIN-LIFT OF SAME RESCUER VICTIM (MATCH ILLUSTRATION)	BLANK	*COMPY (SO) V/O: Here's how that would look in real life. . . . Now we'd like you to try opening the airway on the manikin using this head-tilt/chin-lift method. When you perform on the manikin, you won't need to touch the computer screen to let us know when you've begun, because we'll be able to sense this from the manikin. So go ahead and try it now. . . .* *(Computer program monitors airway sensor in manikin. If airway is not open within 20 seconds, program routes to* HAVE YOU TRIED THAT YET? BRANCH *— Customized/Compy. If the airway is open within 20 seconds, the program proceeds to the* SUCCESSFUL BRANCH*)*
		HAVE YOU TRIED THAT YET? BRANCH *— Customized/Compy* *(Video screen holds image and computer screen goes to yes/no display)*

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TV Monitor	Computer Monitor	Script
Continued	☐ yes ☐ NO	*COMPY (SO) V/O: Did you try it? If you did, answer yes on my screen. If you didn't, answer no.* *(Depending upon response, program advances to* NO BRANCH or YES BRANCH*)* (NO BRANCH) *(Video screen holds image of head-tilt/chin-lift, computer screen goes blank)*
Continued	BLANK	*COMPY (SO) V/O: Well, don't be bashful. Please go ahead and try opening the airway. This unconscious victim needs air to breath.* *(Program continues to return to this response if no action is indicated)* (YES BRANCH) *(Video screen holds image of head-tilt/chin-lift, computer screen goes blank)*
Continued	BLANK	*COMPY (SO) V/O: Well maybe you need to tilt the head back more, and lift up on the chin a little more forcefully. Please don't be hesitant—we want the airway wide open so that this person can breathe. . . . Once you've got it right, we'll proceed—Now, go ahead and try it again.* *Program monitors performance and proceeds to appropriate branch. If two "Yes" answers entered in a row, program reroutes to* LACK OF SUCCESS BRANCH*—Generic/Compy. When airway opens, program proceeds to* SUCCESSFUL BRANCH*)*
ILLUSTRATION In bold, highly elaboRATE SCRipt: "Excellent!"	BLANK	(SUCCESSFUL BRANCH) *(Video screen holds image, but adds TV key, computer screen goes blank)*
(SAME AS EARLIER head-tilt/chin-lift) WE USE THIS TECHNIQUE IF THE VICTIM IS WEARING DENTURES	BLANK	*COMPY (SO) V/O: Excellent . . . And if the victim has dentures, this is the method to use to hold them into place. If rescue breathing is needed, the airtight seal is easier to perform when dentures are in place. But, if dentures cannot be managed in place, remove them.* *(Video screen goes to illustration, computer screen is blank)* Listing 1 shows the programming that brought much of this excerpt to the video screens.

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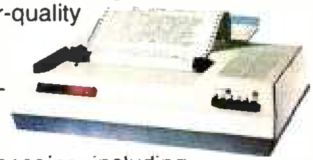

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The Interpretive Language Used to Program the CPR System

Mike Laumer
Laumer Research
1832 School Rd.
Carrollton, TX 75006

The interpretive language developed for the CPR course contains over 80 different operations that make possible the programming of the various hardware elements of the system (light pen, Apple video display, videodisc, audio tape, and manikins). The language is similar to assembly language, with the familiar op-code-argument structure known to assembly-language programmers. About half of the instructions provide the computational and logic abilities of a 16-bit processor, while the other half is dedicated to the special hardware elements of the system.

A powerful sublanguage exists for displaying text and low- and high-resolution graphics on the Apple video screen and for building tables for the light pen commands to work from. The tables for the pen command contain the number of entries in the table and each entry contains the x, y, start and stop coordinates for an active region and an invert region. When the pen command executes any detection of the light pen in an active region of a menu, selection will cause the text in the invert region to be highlighted (black text on a white background) to indicate the current selection, and when the pen moves on to another field the previous field is changed back to normal and the new field is highlighted. Touching the ring on the pen to make a menu selection will return a number indicating the table index that was highlighted last, and a tone sounds on the Apple speaker as audio feedback.

Listing 1 shows a sample course segment coded in the interpretive language, with comments on the operation to the side. The related segment of the script is included in the text box on page 120.

Listing 1: A program segment written in the interpreter especially developed for the CPR project. The interpreter resembles assembly language in its use of op-codes and arguments.

```
        SHOW       23157          ;show a still frame on the
                                  video disk.
        CHAN       #3             ;select channel number 3 on
                                  audio tape unit.
        PLAYA      5740,5930      ;play a segment of audio
  .                               from cassette player but do
  .                               not wait for completion in
  .                               case student catches on to
  .                               the instructions and tries
  .                               the airway opening before
  .                               the voice on the tape
  .                               interrupts from the tape.
  .                               Will shut it off at the proper
  .                               tape address position.
  .
        MENU       A              ;show a menu to student on
                                  the Apple video screen.
CHK     TIMEOUT    30,ERR         ;JUMP to ERR if 30 second
  .                               limit expires and airway still
  .                               not opened.
        WAITAIRWAY                ;wait for student to open the
                                  manikin airway.
        JUMP       GOOD           ;branch to good perfor-
                                  mance if airway opened.
ERR     LIST       B,PENTABLE     ;show a menu for student.
        PLAYA      5940,6090      ;"have you tried that yet?"
```

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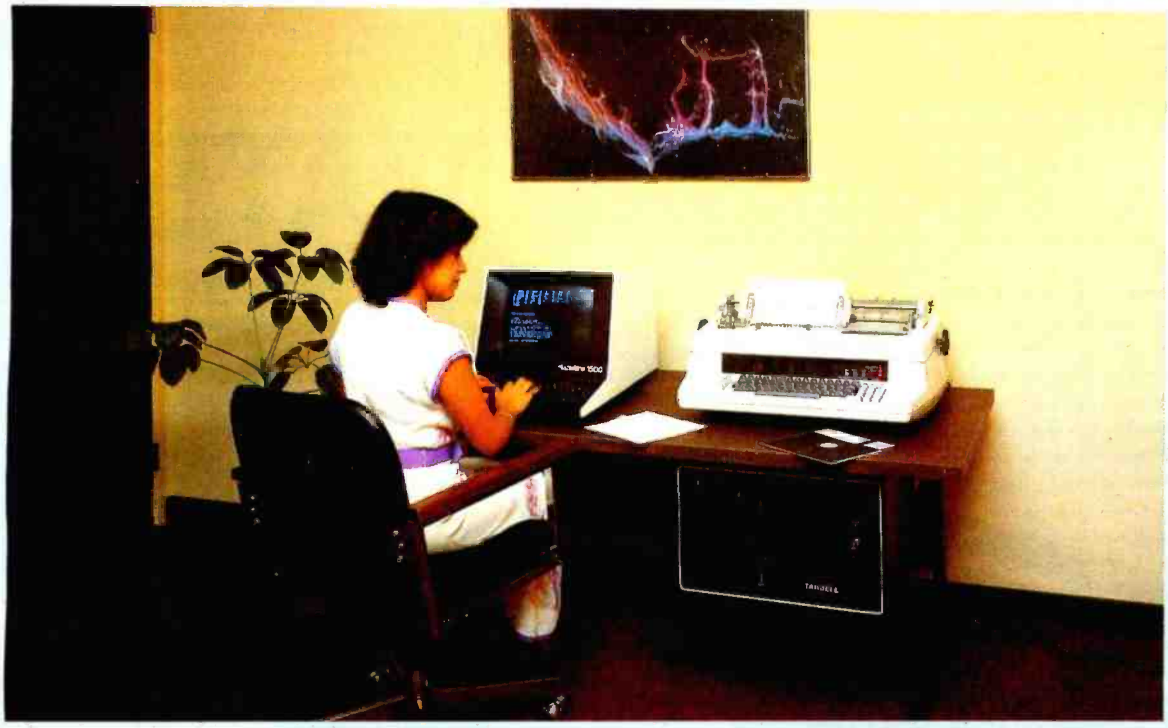

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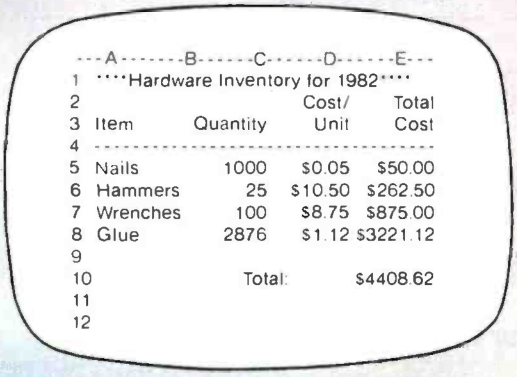

```
   ---A-------B------C------D------E---
 1  ····Hardware Inventory for 1982····
 2                           Cost/     Total
 3  Item       Quantity       Unit      Cost
 4  -----------------------------------------
 5  Nails          1000      $0.05    $50.00
 6  Hammers          25     $10.50   $262.50
 7  Wrenches        100      $8.75   $875.00
 8  Glue           2876      $1.12  $3221.12
 9
10                Total:            $4408.62
11
12
```

ScratchPad includes all the most useful features found in other popularly available spreadsheets, but has added these state-of-the-art innovations:

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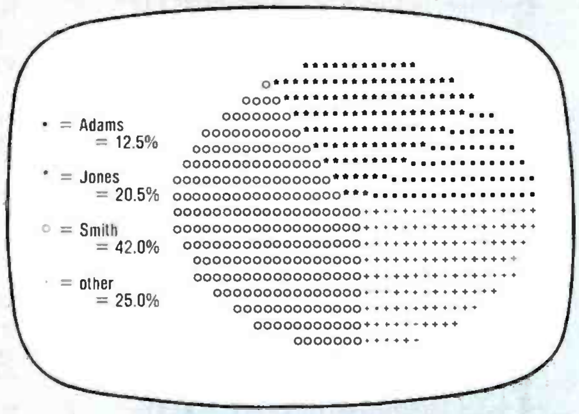

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Listing continued from page 126

```
           PEN        PENTABLE,SELECTCODE    ;wait for student selection.
           GOTO       SELECTCODE,YES,NO
YES        PLAYA      5940,6090              ;"well, will you please try
                                             it . . ."
           JUMP       CHK                    ;go monitor performance
                                             again.
NO         PLAYA      6100,6180              ;"Well, don't be
                                             bashful . . ."
           JUMP       CHK                    ;monitor performance again.
GOOD       . . .                             ;continue with course.
           . . .
           . . .
SELECTCODE            .BS 1                  ;reserve 1 byte for pen
                                             code.
*-----------------------------------------------------------------------
*          MENU DATA SELECTION
*-----------------------------------------------------------------------
*          MENU FOR STUDENT INSTRUCTION
*
A          BEGINMENU                         ;start menu A.
           HOME                              ;clear the screen.
           VTAB 10                           ;goto line 10.
           HTAB 1                            ;goto column 1.
           TEXT "PLEASE OPEN THE AIRWAY ON THE MANIKIN"
           VTAB 12                           ;goto line 12.
           HTAB 1                            ;goto column 1.
           TEXT "WE'LL CONTINUE WHEN YOU OPEN IT."
           ENDMENU                           ;end of menu A.
*
*          MENU FOR HAVE YOU TRIED THAT YET?
*
B          BEGINMENU                         ;start menu B.
           HOME                              ;clear the screen.
           VTAB 10                           ;goto line 10.
           HTAB 5                            ;goto column 5.
           TEXT "HAVE YOU TRIED THAT YET?"
           VTAB 12                           ;goto line 12.
           HTAB 15                           ;goto line 15.
           BEGINFIELD                        ;start a light pen selection
                                             field.
           TEXT "YES"                        ;text for pen selection.
           ENDFIELD                          ;end a light pen field.
           VTAB 14                           ;goto line 14.
           HTAB 15                           ;goto column 15.
           BEGINFIELD                        ;start second light pen field.
           TEXT "NO"                         text for pen selection.
           ENDFIELD                          ;end of second light pen
                                             selection.
           ENDMENU                           ;end of menu.
```

Text continued from page 120:

By far the most difficult parts of the software were the algorithms that governed the evaluation of hands-on performance by the student. The problem was to read the input array reflecting the student's performance and (1) judge whether the performance took too little or too much time and (2) determine whether each part of the performance occurred in the proper sequence. One or the other of these two parameters alone would have been easier to manage. Together they posed difficulties. Based on performance, the software has to display high-resolution graphics and complement these with video demonstrations and explanations of how to improve performance. Figure 3 is a flow chart of the part of the program that teaches external chest compression.

In the text box on page 126, Mike Laumer gives some insights into how the programming was done. Listing 1 is a sample of some code that Mike wrote in the interpretive language developed for the CPR project.

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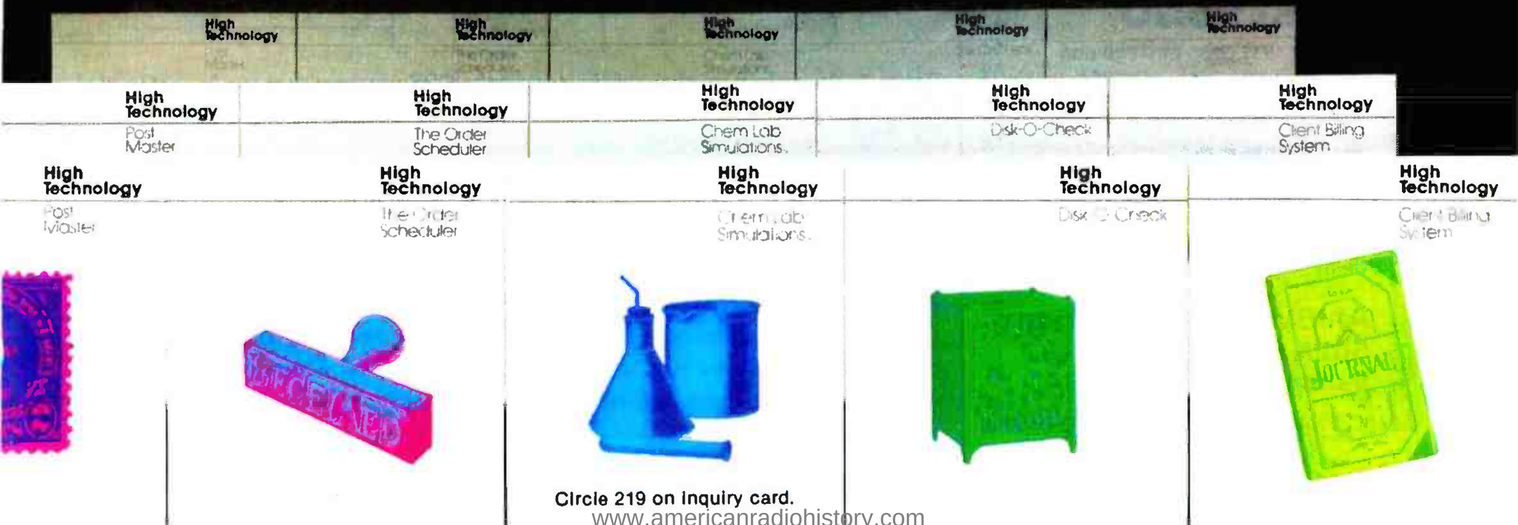

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A0C4C9D3CBA0D5D4C9CCC9D4D9A0A4B5B0A0

A0 D2 C5 D3 D4 CF D2 C5 A0 C4 C5 CC C5 D4 C5 C4 A0 C6 C9 CC C5 D3 A0 A0 A0 A0 C5 D8 C1 CD C9 CE C5 A0 C1 CE C4 AF CF D2 A0 D0 C1 D4 C3 C8 A0 C1 CE D9 A0 C4 C9 D3 CB A0 D3 C5 C3 D4 CF D2 A0 A0 A0 A0 C4 C9 D3 CB A0 D3 D4 C1 D4 D5 D3 A0

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A0 C4 C9 D3 CB A0 C4 C9 D3 D0 CC C1 D9 A0 A6 A0 D0 C1 D4 C3 C8 A0 D5 D4 C9 CC C9 D4 D9 A0 CD C1 CE C6 C1 C3 D4 D5 D2 C5 C4 A0 C2 D9 A0 C1 CE D3 D7 C5 D2 A0 C3 CF D2 D0 A0 A0 A0 A0 A0 C1 A0 D3 CF C6 D4 D7 C1 D2 C5 A0 D4 CF CF CC A0

A0A0C2D9A0CAC5D2D2D9A0D4C9C6C6D4A0A0

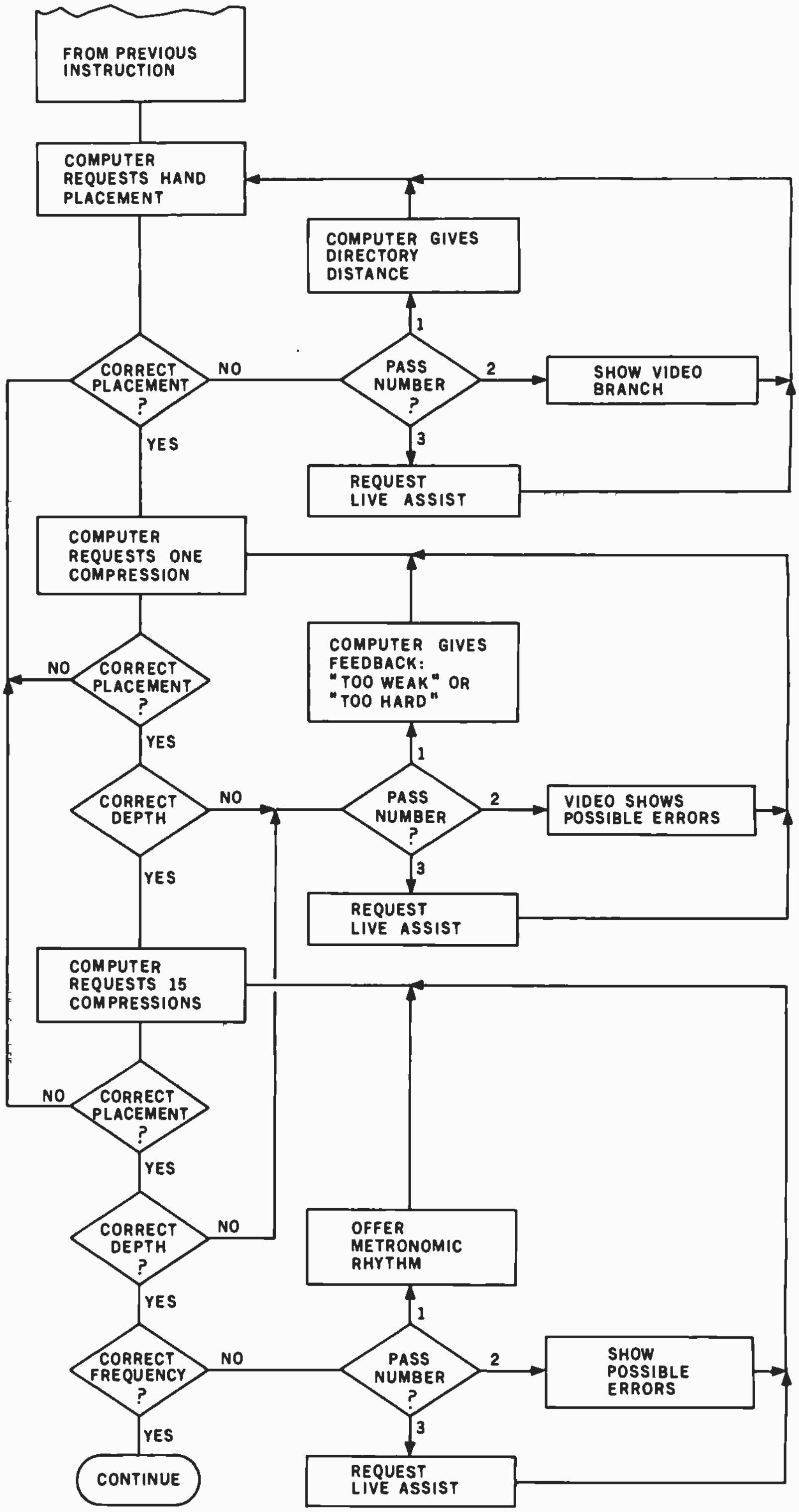

Figure 3: *An early flow chart of the part of the CPR program that teaches external chest compression.*

The Light Pen

There is a big difference between using a light pen to simplify a few types of input and using a light pen as the only input under user control. In our system, the light pen had to do almost everything that a keyboard can but without the keyboard's complexity.

We organized the use of the light pen around a menu of nine choices. The student would choose one of the

"Mr. Holmes, Dr. Watson, I'm really glad you made it," said the office manager who had enlisted the services of my friend. "Last night, a big chunk of data disappeared from our computer system. My boss wants to know who was responsible...and fast!"

Holmes began to investigate.

"You would be wise to exonerate all of those in your employ," he concluded just moments later. "No one here is a fiendish database killer. Last night's lightning storm was the villain. It caused a momentary loss of power that destroyed immense portions of your database."

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"Quite untrue," replied Holmes. "In fact, Zeμs2 offers the best price-performance ratios in the industry—with a price-tag so low some deem it criminal."

"But how, dear man," I interjected, "did you deduce that a power glitch was to blame for last night's loss of data?"

"Elementary, my dear Watson," he said, puffing contentedly on his pipe. "Elementary."

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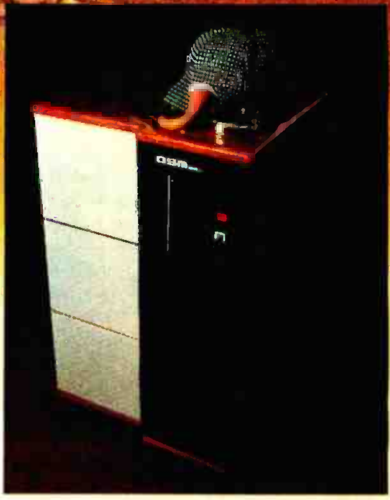

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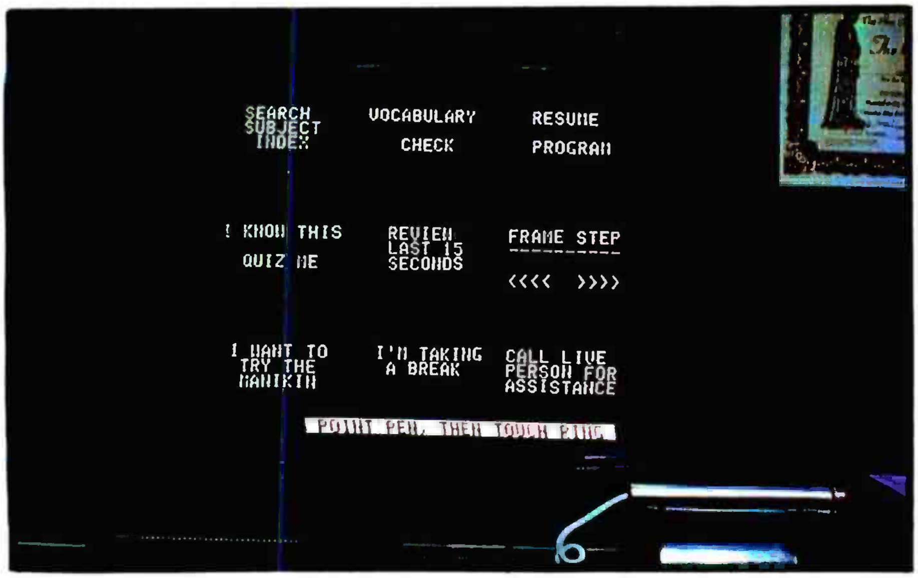


Photo 3: *The main menu of the CPR system. Students select an item by using a light pen. (Photo by Bob Lukeman.)*

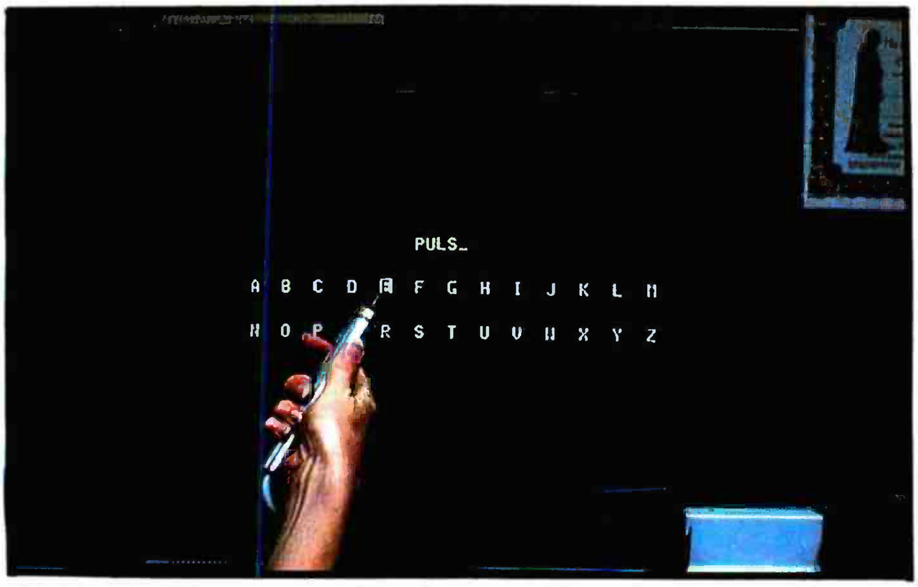
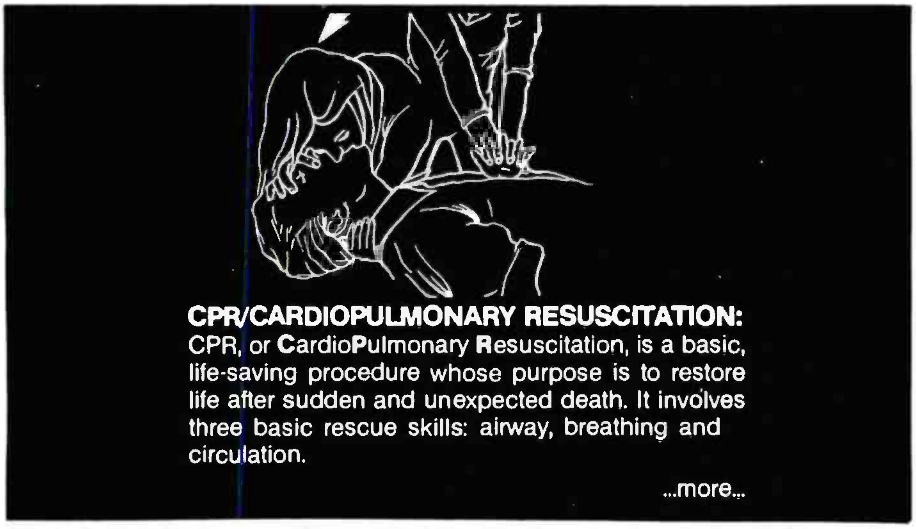


Photo 4: *The CPR system's word template in use. The student is using a light pen to choose a letter. The letter will now appear on the line above the listing of the alphabet. (Photo by Bob Lukeman.)*



CPR/CARDIOPULMONARY RESUSCITATION:
CPR, or **C**ardio**P**ulmonary **R**esuscitation, is a basic, life-saving procedure whose purpose is to restore life after sudden and unexpected death. It involves three basic rescue skills: airway, breathing and circulation.

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Photo 5: *A video frame explaining CPR (cardiopulmonary resuscitation). The student can get a more thorough explanation on request.*

nine items by pointing the light pen at it and, when the block around the item lights up, touching the place between the light pen's two metal rings. The nine choices, as shown in photo 3, include searching a subject index, a vocabulary check, reviewing the last 15 seconds of instruction, stepping through frame by frame, practicing on the manikin, taking a break, resuming the program after a break, requesting a quiz on material that the student thinks he or she knows, and calling a live person for assistance.

Since it was vital to give students the sense of being in control, we wanted the menu to be available always. We decided that two monitors were necessary and would add to the system's capability. One would always be available to take input from the student and to display output from the computer. The other would constantly display information from the videodisc. At times, we discovered, the two monitors could work together as a highly sophisticated instructional tool. Furthermore, the cost of the second monitor was a small part of the cost of the whole CPR system.

If at any point in the instruction the student gets bored rehashing, say, the anatomy of the heart, the student can switch to "I know this—Quiz me," or to "I want to try the manikin." Such freedom keeps students interested.

To provide for alphabetic input from the students, we provided a "word template" system that provides a listing of the alphabet and allows the student to spell out a word by touching characters in the list. Photo 4 shows the template in use. The software here can handle most misspellings of the words intended. Rather than insisting on exact spellings, the software checks to see if key letters are present in the correct order. If the student is trying to spell "pulse," the software will understand so long as the student enters the letters "PLS" in that order, regardless of the letters that come before, after, or in between.

The light pen provides access to several different levels of explanation of the key vocabulary words. Each level may involve printed and spoken

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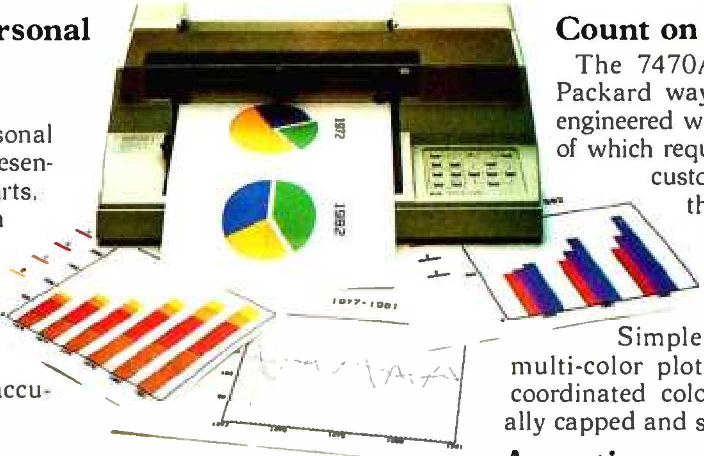

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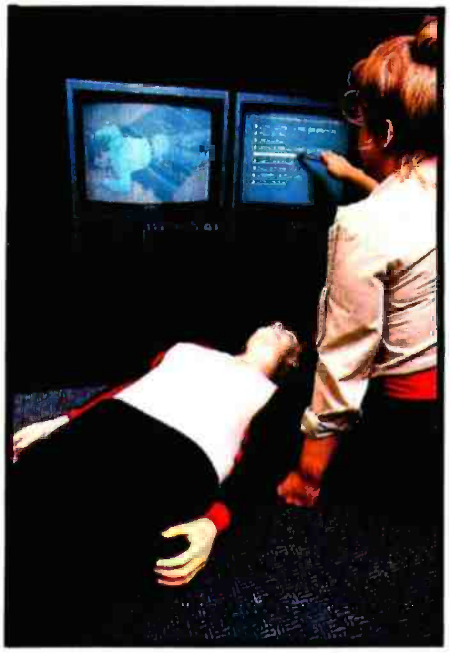

6b

6c

6d

Photo 6: *A student using a light pen to show judgment. In photos 6a and 6b the computer screen displays a list of techniques out of order and the student indicates the next one in the order, which, if correct, will appear above the dotted line. The computer then accesses the videodisc to present the appropriate next segment on the video screen while the list of techniques remains visible on the computer screen (6c). In photo 6d the student makes another selection.*

explanations and labeled illustrations. The first definition provided is short and simple, letting the student quickly check the correctness of his or her understanding of the term. The student can always use the light pen to enter "M" for "More" to get a deeper level of explanation. Photo 5 shows a frame with a basic explanation of CPR.

Students also use the light pen during quizzes, as shown in photo 6. Providing different levels of explanation on demand helps to implement the "mosaic" concept of learning, as opposed to the traditional step-by-step, same-for-everyone, linear concept. The system meets the needs of each student. People who want more thorough definitions can always get them. People who just want to learn enough to perform CPR need not go to such lengths.

One benefit of the mosaic approach is that a single nucleus program can satisfy several different levels of learning needs. This helps a great deal in amortizing development costs.

Random-Access Audio

In order to keep up with the videodisc, a random-access audio system would have to be fast indeed. I reasoned that 1/30 of a second would be fast enough on stereo audio tape, and that three usable channels could give us three times the speed of access. To build the random-access sound machine, I commissioned Bob Howard and Dave Weiszbrod of BCD Electronics in Oklahoma City, Oklahoma. They were the logical choices because they had already developed a successful frame-accurate video-tape interface card for the Apple II.

There was a certain irony in developing random-access audio at all. Audio technology had preceded video, but it was video technology that first achieved random access. Now we were going back to give the older audio technology one of the fruits of the newer video technology.

How It Worked Out

Pending final validation results, the system will be used to train from one

The Availability of the CPR Training System

People interested in obtaining the CPR videodisc training system described by David Hon should contact Interact Inc., 603 NE 17 St., Oklahoma City, OK 73105, telephone (405) 521-9073. Interact's chairman is Dr. Daniel Cassidy, an emergency care physician with a strong interest in interactive video. Jack Roseman, former head of Online Systems, is Interact's president.

Interact has other videodisc-based medical training systems under development. Another American Heart Association course, the Advanced Cardiac Life Support (ACLS) program will train physicians, paramedics, and nurses in what to do after CPR, including medical management of cardiac arrest cases in all eventualities.

In addition, Interact will release at the same time as the CPR system another videodisc that creates simulations of cardiac arrest cases. The disc will randomly generate particular types of cardiac arrest, based on the real probabilities for the exact nature of the case and the condition of the patient. The system will then ask the trainee to decide on the correct therapy. The system provides feedback at every step, telling the student how to correct any mistakes, and continues the simulation until the case is managed successfully.

Interact will soon be opening new headquarters in Pittsburgh, Pennsylvania.

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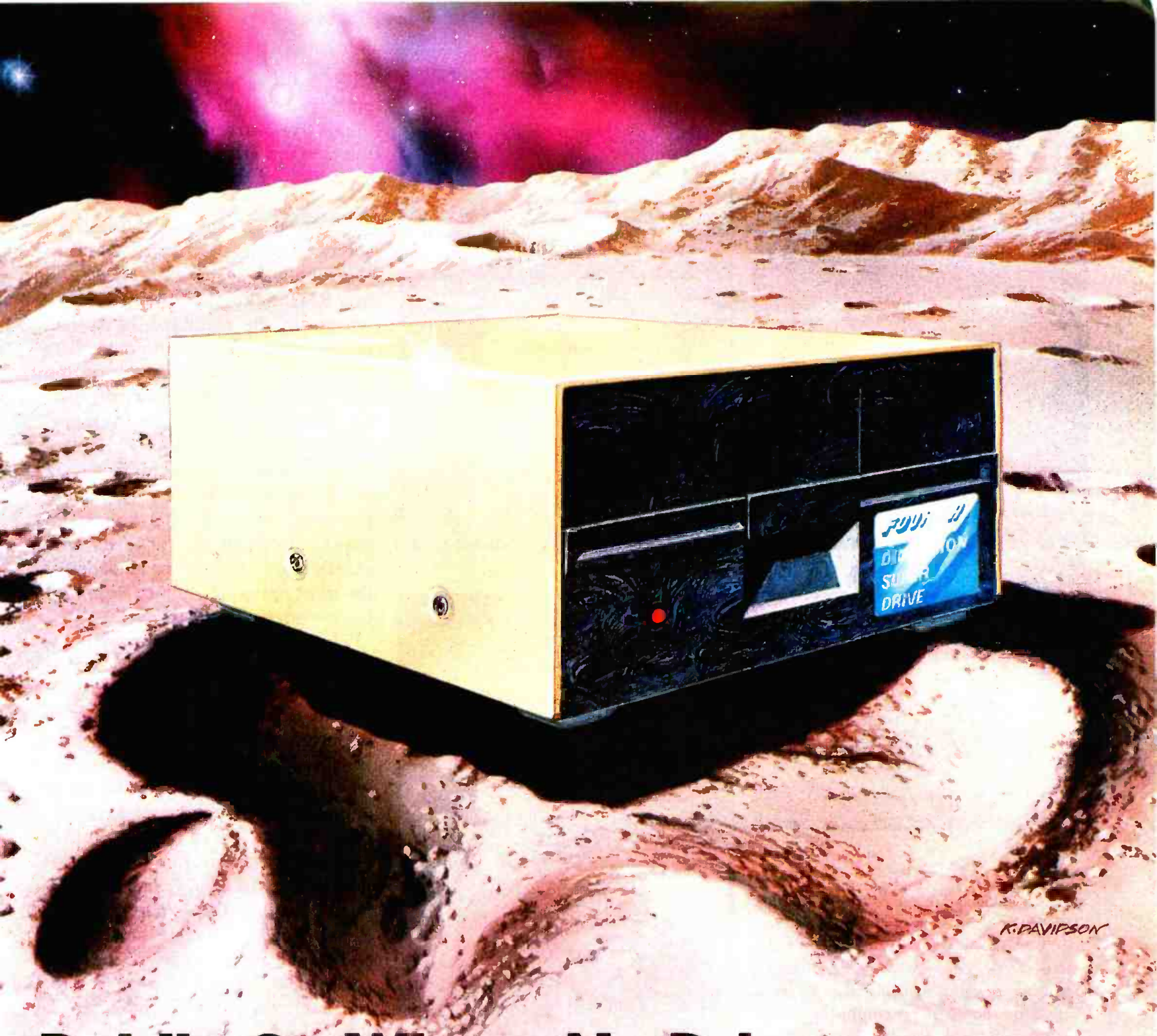

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7a


7c


7b

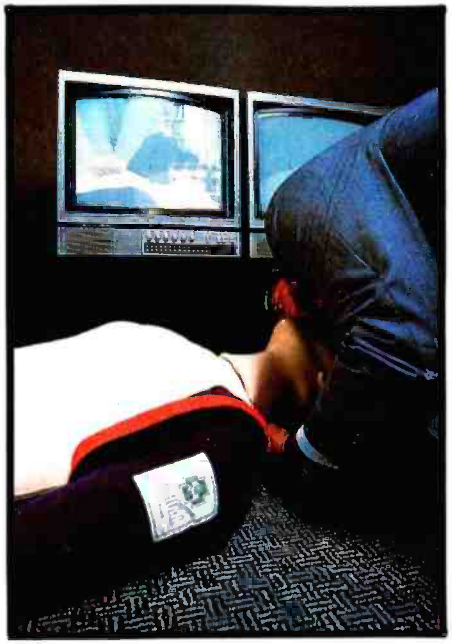
7d

Photo 7: *The system in use. Photo 7a shows the author, in the role of a student, performing chest compressions on the manikin. In 7b the doctor, seen on the video screen, comments on the student's performance and explains the graphed evaluation shown on the computer screen. The student then goes on to perform a ventilation (7c) and "interacts" with an on-screen rescuer in simulated two-person CPR (7d).*

to four people at a time in the techniques of CPR, with no assistance from a human instructor. If more than one person takes part at a time, the system evaluates each individually. The system also serves as an effective and rapid recertification tool for persons who have previously completed a course in CPR. If the system is used two hours a day, as many as 1700 persons who completed their previous courses six months ago may be recertified in one year.

The flexibility of mosaic courses makes it difficult to say how long the course should take to train any one novice, but the range seems to be from one to five hours, depending on prior medical knowledge, with three hours about average for completing the entire course. When the system is training four people at a time, the expected duration is about four hours; for a recertification after six months, about half an hour; for a recertification after one year, about an hour.

Our early tests show that we accomplished what we set out to do. The CPR student never sees an instructor or a keyboard but is taught CPR skills and is certified more quickly *and* with higher standards than a live instructor can achieve. By the time this article appears, our final validation of these results should be complete.

One of the reasons for the system's success becomes apparent only to someone who watches the system in use. Reacting to data supplied by the sensors in the manikin, the system gives far more precise and immediate coaching about the student's position and the depth and rhythm of compression than any human instructor could provide (see photo 7). An individual human instructor can't get inside the manikin the way technology has. An individual human instructor can't always be ready with exactly the right word of guidance or the most apt graphic illustration. But the system is always ready.

The videodisc's large storage capacity and high-speed random-access capability made the system possible, but the technology only presented an opportunity. Human ingenuity had to seize that opportunity. Our success was in bringing together the talents of cooperating physicians, programmers, engineers, and video experts to exploit videodisc technology. It is as if videodisc technology and the computer distilled the expertise of all these people into one small, self-sufficient, and convenient package for optimal presentation to a wide range of individuals. From our results it should be apparent that videodisc technology presents a real opportunity for concentrating expertise and imparting skills in many other fields as well. ■

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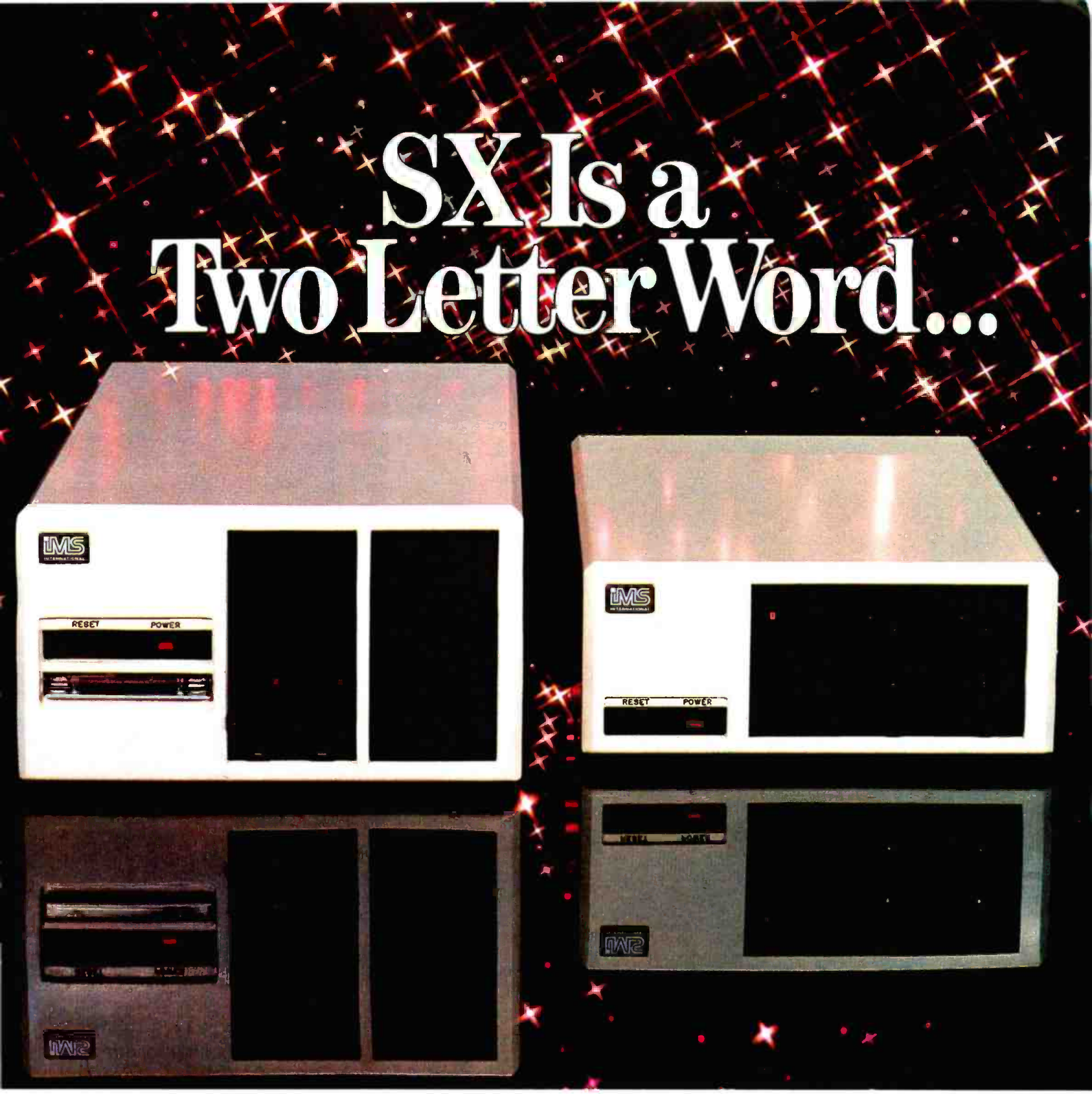

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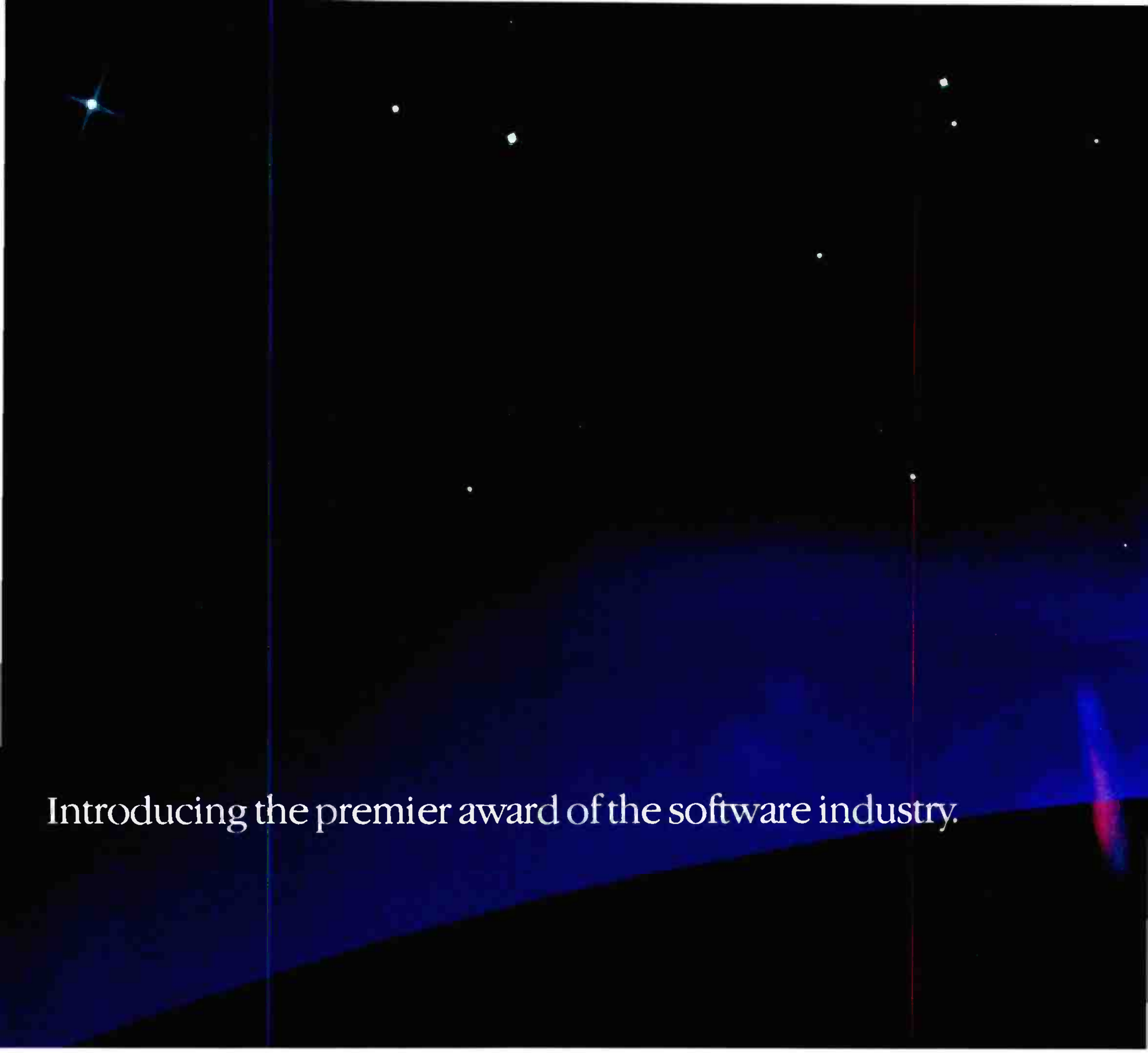

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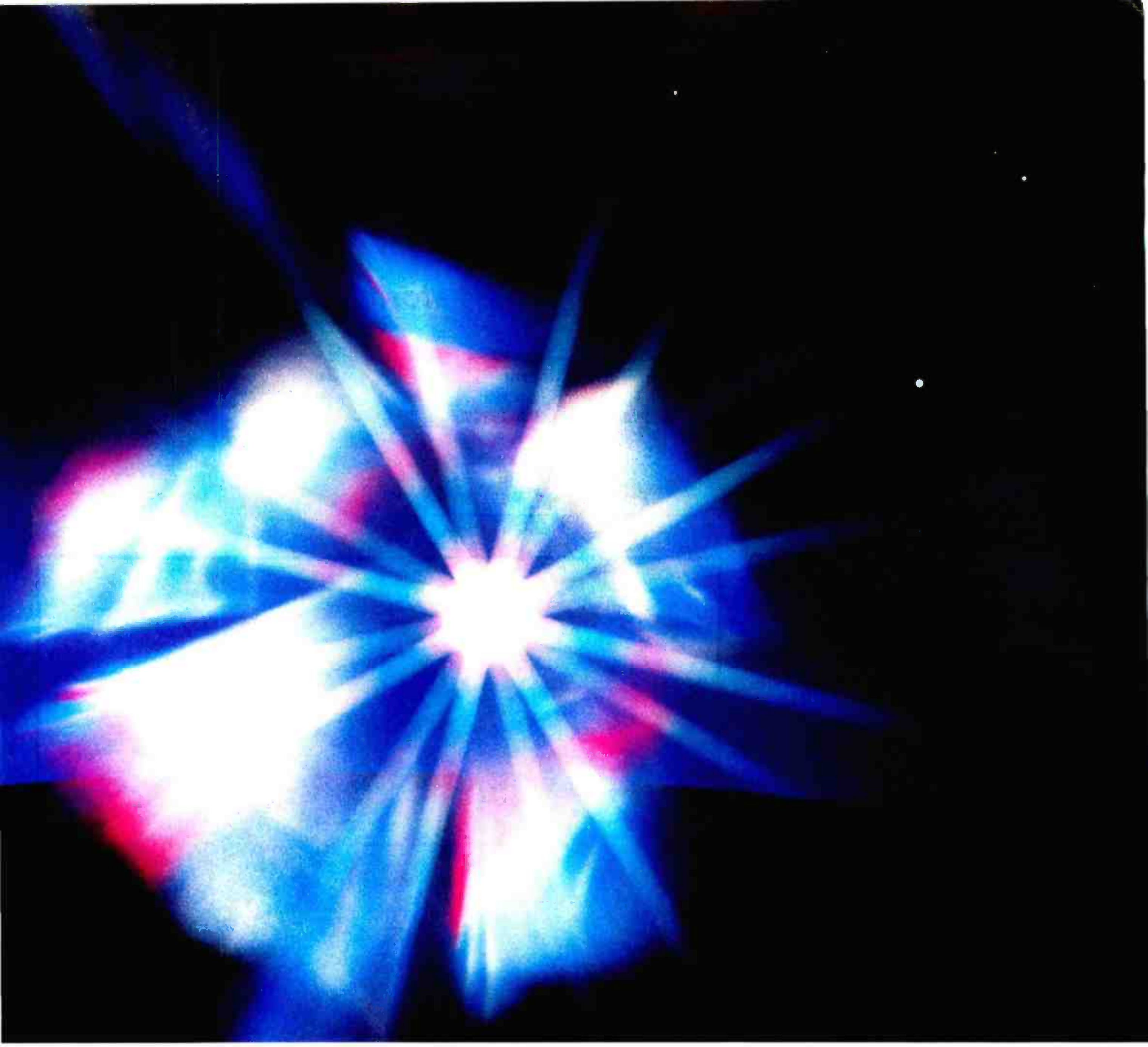

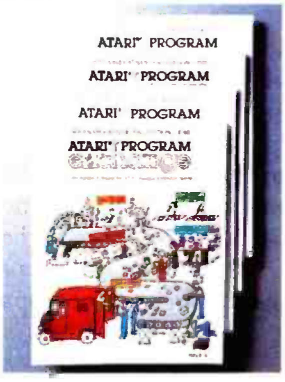
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Videodiscs and Optical Data Storage

We may soon be measuring mass storage in gigabytes.

Dick Moberg
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Ira M. Laefsky
8808 Patton Rd.
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Optical videodisc technology may be the next generation in mass storage of digital data. Though much of the effort to date involves large, expensive recording machines, some of the research is geared to the mass production of large databases that will be accessible by small-computer systems. In just a few years, your personal computer may be able to randomly access an entire encyclopedia, including text and photographs.

This article will review some methods of storing digital data optically on videodiscs. We will then look at some commercial products for office automation and mass data storage that are being developed using optical-storage techniques. Finally, we will assess the benefits this technology promises the small-computer user in terms of large databases of text and pictures.

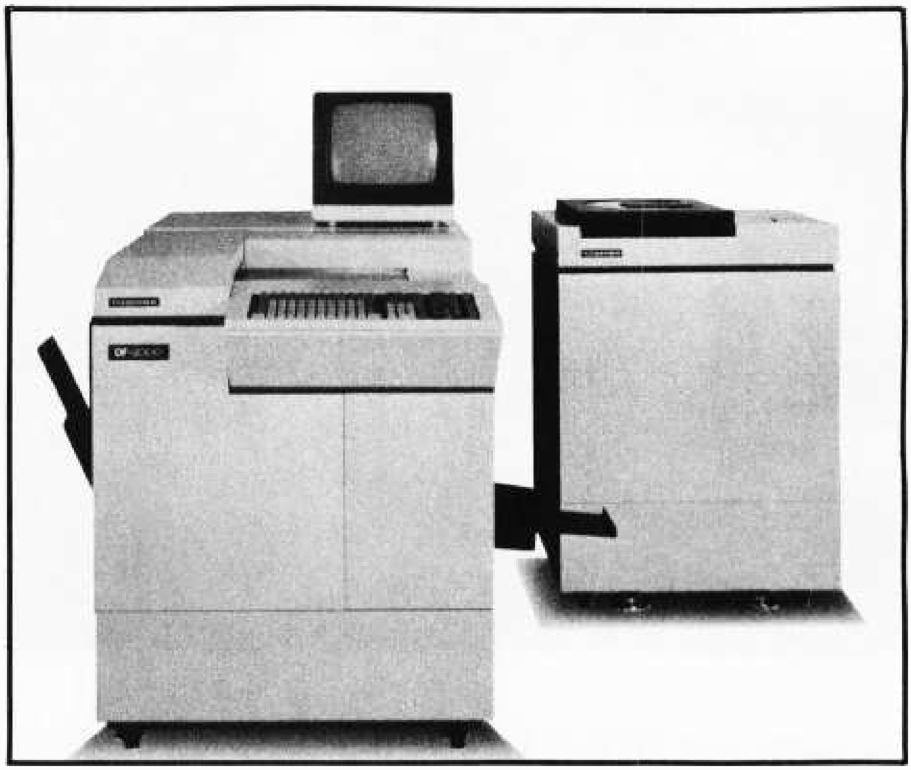

Photo 1: *The Toshiba DF-2000 Document Filing System.*

Trends in Data Storage

Let's look at the trends in data storage over the last two decades. In the 1960s, computers, for the most part, were still being used for storing numbers; businesses, banks, and the government relied on high-capacity magnetic hard-disk packs for data storage. The 1970s saw an increased need for storage of text: letters, manuscripts, and memos became increasingly important as our world became more knowledge-dependent. Word processors and office-automation systems popped up everywhere during the 1970s, and the floppy disk, with its limited capacity but low cost, came into vogue.

Magnetic-storage technology has, until recently, kept pace with user requirements. Magnetic-tape density has increased from 800 bpi (bits per inch) to 1600 bpi and now to 6250 bpi. Low-cost hard disks presently offer many megabytes of storage for small-computer systems; but data-storage requirements are again changing. Entire documents must be stored, including graphics and pictures, increasing the memory required by two orders of magnitude. This challenge to the magnetic-media industry may give optical-storage technology the chance it needs to become a commercial reality.

The need for document storage is everywhere. In large institutions, file cabinets are grabbing more and more floor space. At the Jet Propulsion

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Laboratory, photographs sent from space fill reel after reel of magnetic tape. Most hospitals have X-rays stacked to the ceiling for the duration of their legal storage term. The U.S. Government alone used 2 million reels of magnetic tape in 1975. Microfilm has had some impact here, but the time needed to access the stored information limits microfilm's usefulness.

Progress in the fields essential to the success of optical storage has been excellent. The development of the single-mode laser diode to replace the large, expensive gas laser has made the consumer videodisc a reality. Recent advances in microprocessor technology, error-detecting and error-correcting codes, and database techniques are also key elements to the success of this effort. The stage is now set for the creation of an optical data-storage industry.

How Is Information Stored?

Storing digital data on optical videodiscs can be accomplished in two ways. In one method, the digital data is encoded in the video signal, then standard videodisc replication and reading techniques are used. The other method writes the digital information directly onto special discs. This method has applications in archival storage, whereas the first method is good for databases that must be easily replicated.

We will first review how video information can be stored on conventional optical videodiscs and show how this technique can be used to produce databases for small-computer systems.

For the purposes of this discussion, the scanning pattern of the electron beam inside the television's picture tube can be thought of as comprising 525 horizontal lines from top to bottom (the process is called raster scan). This scan produces one image (frame) on the face of the tube. The scan is repeated every 1/30 second, producing a new picture each time. (Actually, two *interlaced* frames of 262.5 scan lines are produced, 1/60 second each.) The picture data of each horizontal scan line consists of a varying

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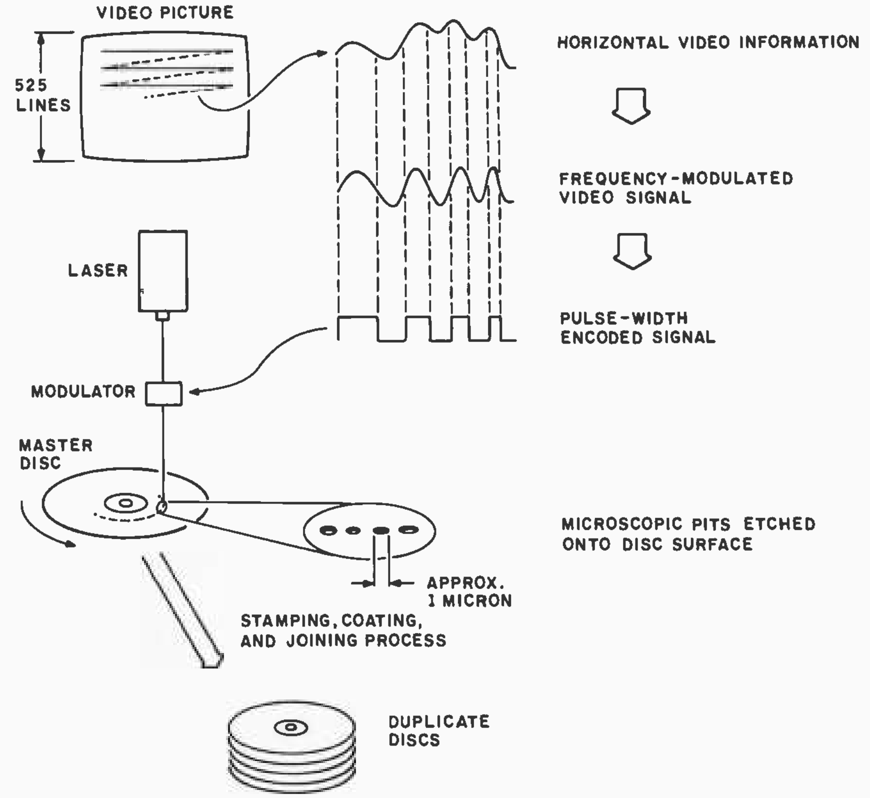

Figure 1: *Information storage on a videodisc. The first step in storing video information on a videodisc is the production of an FM (frequency-modulated) signal from the horizontal scan information of the TV signal. Next, a pulse-width encoded signal is made by "clipping" the top and bottom of the FM signal. This signal is used to modulate a high-powered laser that etches pits onto the surface of a rotating, photosensitized glass disc. The pit length is proportional to the pulse width of the original signal. A nickel-plated copy is made to stamp one-sided plastic discs. After a reflective coating is added to the plastic disc, two are joined together to form both sides of the finished disc.*

amplitude signal. The signal controls the intensity of each pixel (picture element) on the line (see figure 1). Sync pulses, both horizontal and vertical, make sure that the scan dot is at the same spot on the screen every 1/30 second. This is a standard video signal.

A videodisc master is made by first converting the AM (amplitude-modulated) video signal into an FM (frequency-modulated) signal. The tops and bottoms of this FM signal are "clipped" to make a pulse-width encoded signal, which is then used to modulate a laser focused on the photosensitized surface of a rotating glass disc. The laser etches tiny pits into the surface of the disc whose lengths correspond to the widths (time) of the pulses. One circular track on the disc holds all 525 horizontal lines needed to produce one TV frame.

From the glass master, a nickel stamping disc is made by a plating process. Plastic discs are then stamped and a reflective coating is added. Two of these discs are joined together to form a two-sided disc.

When reading the picture information back from the disc, a laser is aimed at the track and the reflection of the laser beam is detected. The reflected beam is broken by the pits in the disc, thus modulating the beam to give the pulse-width encoded signal from which the original video signal is reconstructed (see figure 2).

What about digital-information storage? From the above discussion, it can be seen that the pulse-width encoded signal is essentially an on-off digital-like signal. As you might expect, with the proper encoding scheme, digital information can be stored on a videodisc with little modification to the recording and

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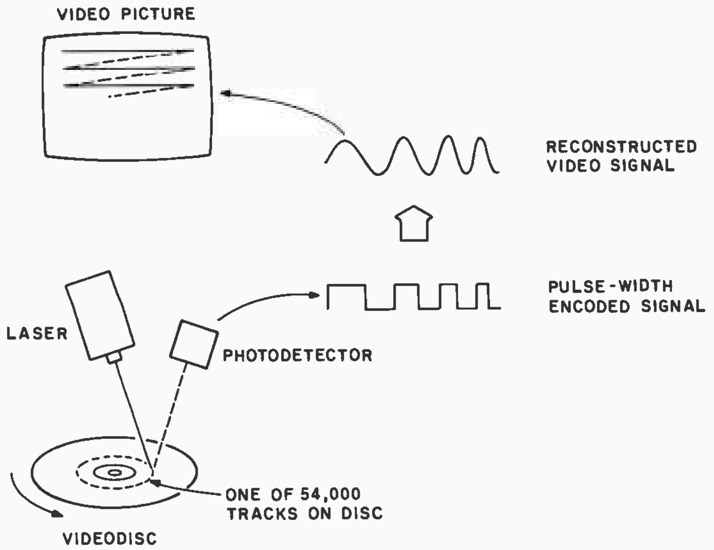

Figure 2: *To read video information from a videodisc, a laser is focused on a track of the disc and the reflected light is picked up by a photodetector. Pits in the tracks break the reflected beam of light and produce the pulse signal that is decoded into the original video signal.*

playback equipment. (In practice, it is not quite that simple. A few of the problems will be discussed later.)

For now, let's calculate how much digital data can be stored on a disc. We will start with the fact that, at 4 megahertz (the bandwidth of a television signal), each horizontal line contains 416 pixels. Although only 483 of the horizontal lines carry a picture signal in a TV signal, approximately 500 can be used for digital data storage. If we assume each pixel can represent either a 1 or a 0, the number of bits per TV frame becomes:

$$416 \frac{\text{bits}}{\text{line}} \times 500 \frac{\text{lines}}{\text{frame}} =$$

$$208{,}000 \frac{\text{bits}}{\text{frame}}$$

But the intensity of each pixel of the TV frame can be varied more than just on and off (1 or 0), representing only one bit of information. If we assume at least four intensity levels per pixel, two bits of information can be encoded per pixel, which gives us 416,000 bits/frame.

As was mentioned earlier, one TV frame fits on one circular track of a videodisc. Thus, the standard half-hour videodisc has:

$$30 \frac{\text{frames}}{\text{second}} \times 1800 \frac{\text{seconds}}{\text{half hour}} =$$

$$54{,}000 \frac{\text{frames}}{\text{disc}}$$

Thus, the total disc capacity for this example is:

$$54{,}000 \text{ frames} \times 416{,}000 \frac{\text{bits}}{\text{frame}} =$$

$$22 \times 10^9 \frac{\text{bits}}{\text{disc}}$$

This is approximately 2 billion characters (2 *gigabytes*) per side of a videodisc. If we can detect reliably more than four intensity levels per pixel, the number is even higher. The number of intensity levels is a function of the bandwidth of the TV signal. The best estimates indicate that eight levels would be feasible in data storage of this type, resulting in approximately 3 billion characters per side of the disc.

Three billion characters translates into approximately 750,000 pages of text (assuming a fairly dense page) or, for example, four years of 78 technical journals (assuming 200 pages per journal per month). And that is on only *one* side of a randomly accessible videodisc.

A significant problem with recording digital data on videodiscs in the same manner as a video picture is in the tolerance to errors. In a television frame, one pixel or a hundred pixels of the wrong intensity can hardly be detected. In fact, the videodisc-mastering process sometimes causes the signal of an entire line to be very weak, a condition called "dropout." To correct this error, players are equipped with detectors that sense the signal strength; when dropout is detected, the previous line is substituted for the incorrect line. To the viewer, this substitution is not noticeable.

The story is different with digital data because the intensity level of just one pixel may be responsible for up to three bits of data. Herein lies one of the major problems with optical storage of digital data directly as a video signal. Error-detection and error-correction codes are being used to attempt to reduce the rates. Fortunately, the disc has ample room for redundant information.

Databases for Small Computers

The production of videodisc databases using the recording format just described is being researched at the Lister Hill Center in Bethesda, Maryland, which is the medical-communications arm of the National Library of Medicine. It is responsible for indexing the tremendous amount of medically related literature published each year. The index is sent to subscribers as a multivolume set some three to four feet thick.

Naturally, the Center is interested in publishing its indexes and other medically relevant information in machine-readable form. It has started a digital-videodisc program that, unlike most of the corporate ventures, is aimed at the mass publication of data using mastering and replication processes currently used for videodiscs in the entertainment industry. In this manner, it will be able to mix digital and video information—an added plus when dealing with medical information.

The Center's calculations indicate a

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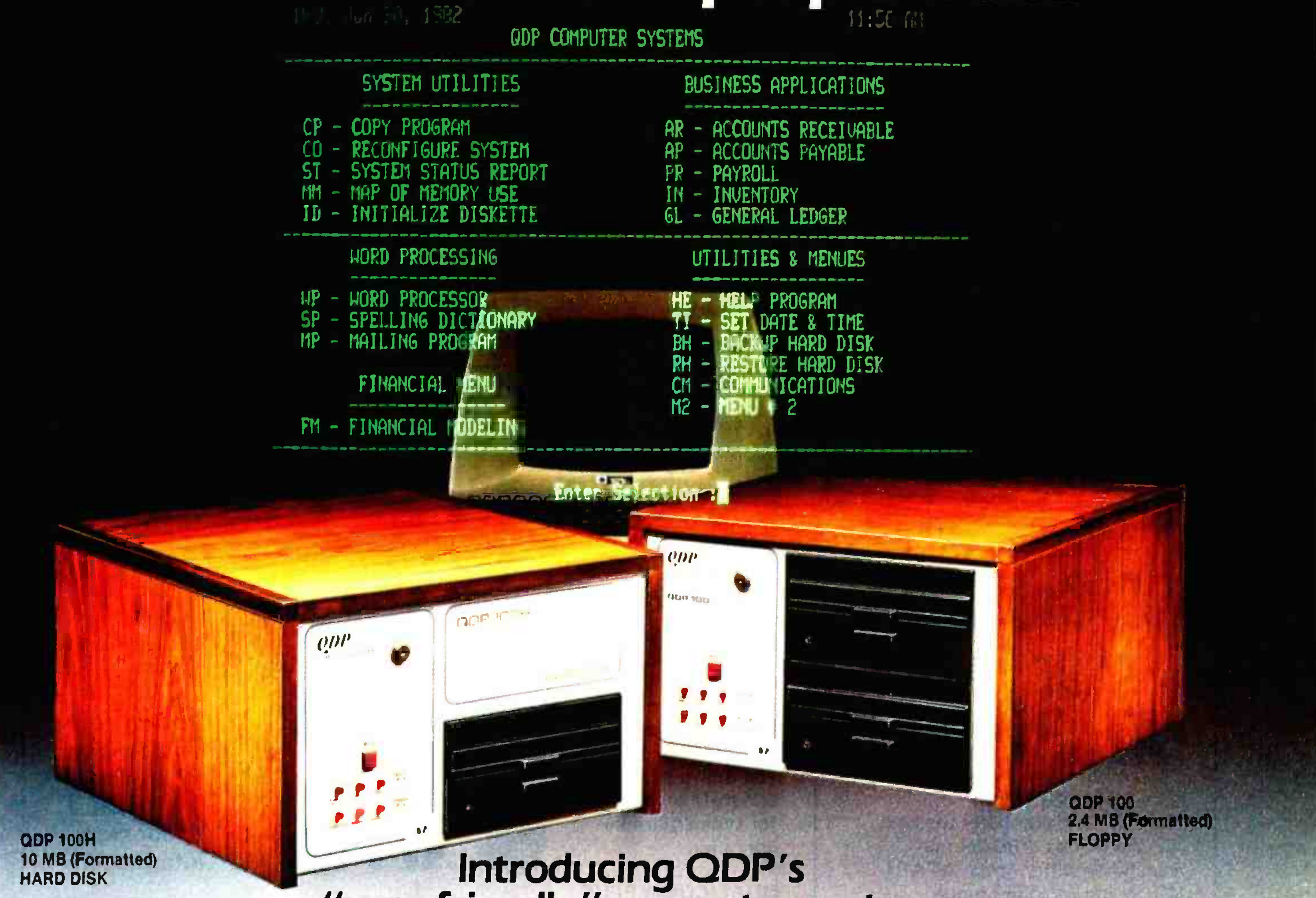

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- Software Languages: COBOL, FORTRAN, C, PASCAL, and Microsoft BASIC.
- 16 bit version available this fall.

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potential for storing approximately 1 billion characters per disc, the equivalent of more than 1000 novels per disc. This would allow storage of its online indexing information base on one to three discs. The Center has developed a VIU (videodisc interface unit) that has been used experimentally in the following research objectives:

- to determine the maximum density of data storage achievable, assuming no errors
- to identify the errors produced as a result of the commercial videodisc production processes
- to identify and test error-correction algorithms for purposes of maximizing usable stored data

The successful completion of this study could be the beginning of large, mass-producible databases usable by small-computer systems. The databases could contain a mixture of character and picture data, making such things as an electronic encyclopedia feasible.

Direct Storage

The other method for storing digital information on optical discs allows reading and writing with the same machine. A relatively high-powered laser beam focused on the surface of a specially made disc burns a small pit into the disc (as in the other method). A second laser/detector combination immediately reads the pits just etched onto the disc and verifies the data. This technique is called the DRAW process for direct read after write (see figure 3). If errors are found in the read that occurs after the write, the computer rewrites the data into a new sector of the disc. This has been a very effective method for reducing error rates to within acceptable limits.

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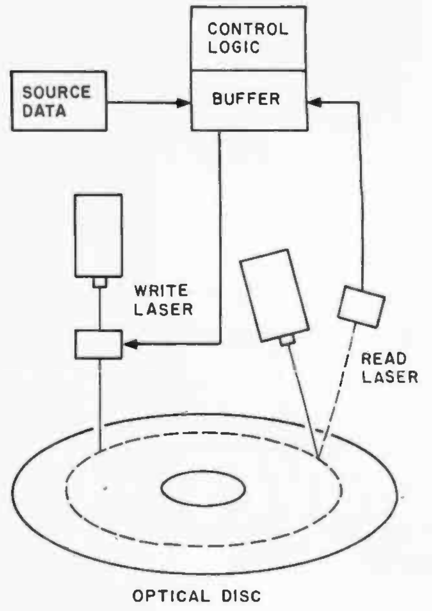

Figure 3: *The direct read after write (DRAW) disc process. Data is written onto a disc by modulating a laser beam much the same as with standard videodiscs. The data, digital to begin with, is stored in a buffer while it is written. Immediately afterward, the same data is read from the disc and compared to that in the buffer. If it is identical, the next track of data is read in; if not, the prior track is rewritten until correct.*

tracks per side, 32 addressable sectors per track, and 15,200 bits per sector. They are preformatted, allowing random access of any of the sectors. Although old data cannot be overwritten or erased on these discs, their 10-billion-bit capacity means that the amount of redundant information is insignificant.

The DRAW process led to industry excitement in developing commercial products. Though no products are currently available, many companies are working toward that goal and a few product announcements are expected this year. We will now look briefly at some of these developments.

For quite some time, it has been known that a TV signal stored on video tape contained lots of information in a very small space. Storage of video data began to interest the government. In 1978, it asked Magnavox to build a video-based product for digital data storage. Magnavox, at that time, was beginning to produce

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videodiscs and was familiar with the technology.

Magnavox developed a prototype system using a gas-argon laser to record on tellurium-coated plastic discs. The disc had a capacity of about 2×10^{10} bits. Although announcements of an industrial product appeared in the trade media about September 1979, Magnavox abandoned the project in 1980 to devote time to the development of a laser diode-based optical-disc system that would replace the large gas-argon laser. From this prototype system, however, parallel efforts began at a number of companies, including RCA, Exxon, Phillips, Thompson-CSF, Xerox, Zenith, and some smaller companies.

Both Xerox and France's Thompson-CSF have ongoing research efforts in optical-disc data-storage technologies. Thompson placed an industrial videodisc player using a transmissive technology on the market in early 1980 and has been developing optical-disc recordings in its French research labs. Xerox performed optical-disc research in its Palo Alto Research Center that was concerned with digital data storage.

About mid-1980, Xerox and Thompson formed a joint licensing agreement to exchange know-how in optical-disc storage, presumably with Xerox to market in the U.S. and Thompson in Europe. Xerox is currently pursuing product development at its Optimem Division. By late 1983 or early 1984, Xerox plans to produce an optical digital-disc cartridge with 10^{10} bits of storage and 160-millisecond access time that will probably sell for about $10,000.

In mid-1979, a group of entrepreneurs who formerly worked on optical discs at Zenith received a large sum of venture capital from Exxon Enterprises to establish a development facility for optical-disc-based computer memories. By mid-1980, a prototype using a gas-laser optical-disc system was developed that interfaced with upper-end IBM mainframes. It used a disc in a cartridge having a capacity of 7.5 gigabytes, and was to have been available at the end of 1982 for a cost of $20,000 to $30,000. Discs were expected to be priced at $150, or $350 for a double-sided disc in a cartridge.

The company, Star Systems, apparently encountered a number of administrative problems and Exxon sold it to STC about mid-1981. Recent technical efforts are moving toward a laser diode-based system at a cheaper cost, and Exxon is aiming its product at the office-automation market as a work-station system for document display.

SRI International recently developed a document-storage system consisting of a laser scanner/printer for input and output and a videodisc for storage. This unit, the Laserfile, looks and operates like a standard office copier and even produces copies on plain paper (see figure 4).

The requirements for the development of this system were:

- Document resolution must be comparable to that of an office copier

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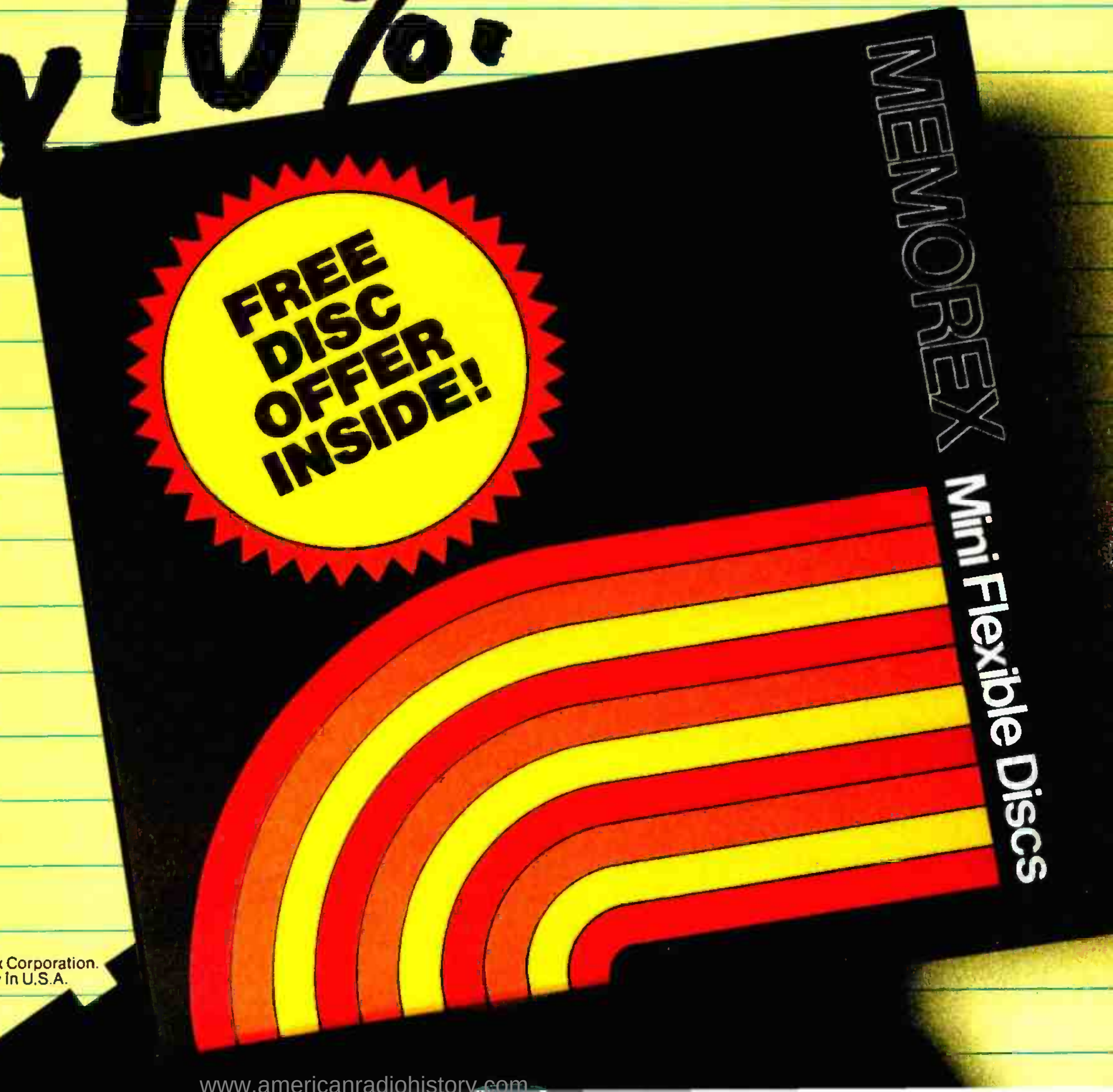

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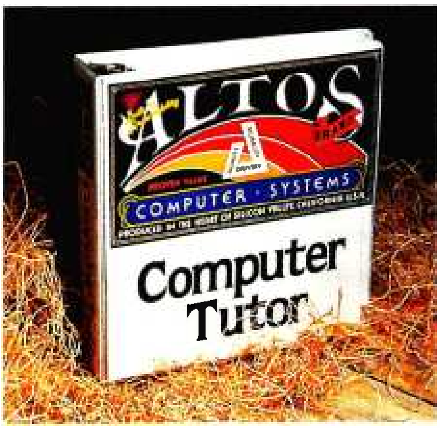

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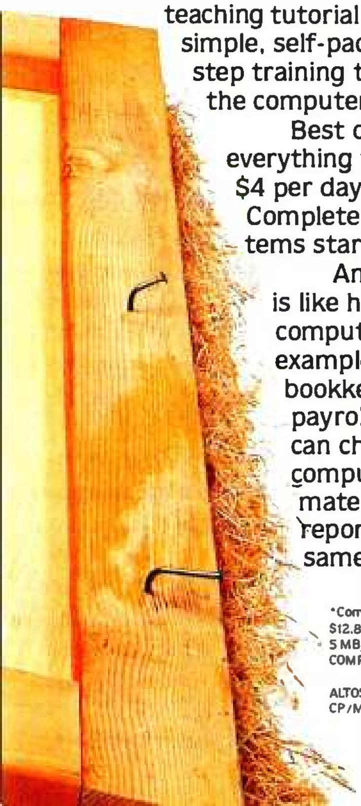

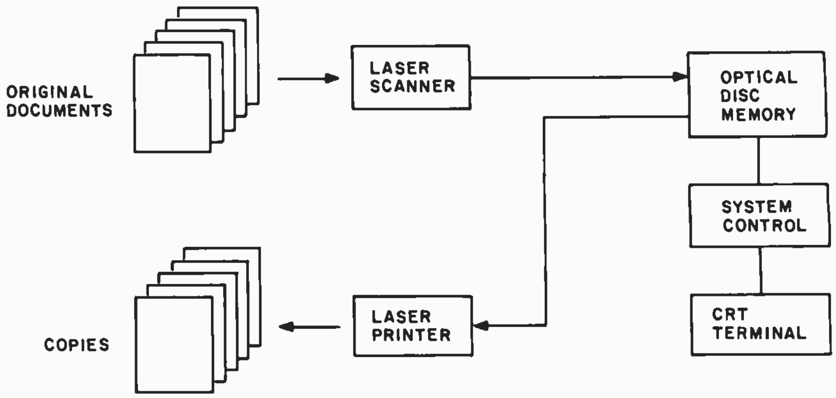

Figure 4: *Block diagram of information flow in the Laserfile, now produced by Toshiba. It acts similar to an office copier except that each document is stored on an optical disc and can be retrieved by the console and printed.*

(fewer than eight lines per millimeter) and must have continuous tone capability.

- Document copies must be retrieved in about three seconds and printed on plain paper.
- The data should be directly readable after writing on the disc (a so-called DRAW disc) to check the quality of the stored document.
- A disc must be postable; that is, new documents can be added at any time until the disc is full.
- The system should store about 4000 documents (2000 per side).

The Laserfile development proved successful and is being produced by Toshiba. It has nearly the same information-packing density as high-resolution microfilm (a 50-times reduction) since both operate near the optical-diffraction limit. But the advantage of the optical technology is in its ease of retrieving and printing copies at the machine or remotely. In terms of storage capacity, a standard 2-foot-deep file drawer can hold about 4500 tightly packed sheets of paper. Therefore, the Laserfile holds approximately one file drawer per disc. An added advantage is that a document cannot be misfiled, lost, or damaged.

Toshiba renamed the Laserfile the DF-2000 Document Filing System, and a model was shown at the 1981 National Computer Conference. It looks like a standard office copier with a computer terminal built in (see photo 1). This version has a capacity of 10,000 document pages per disc. To retrieve a document, you enter an address code on a keyboard and the image is shown on a video display within three seconds. The document can also be printed by the laser printer. Toshiba is directing its marketing to commercial and government organizations with large paper files. The production model should be available in 1983 at a cost of about $120,000. Since images are digitally encoded prior to their recording on the disc, such a system might easily be integrated with facsimile or computer networks.

RCA's efforts in optical-disc data storage are among the most technically advanced in terms of storage capacity and data rates. RCA uses a stronger gallium-arsenide laser and an ablative recording technique. Data rates have been more than 50 megabits per second, with a maximum of more than 12 gigabytes of storage.

It appears that RCA's commercial objectives with DRAW disc systems are limited to high-end government applications. The company plans to market a high-performance, specialized system for $500,000.

Hitachi, a major Japanese computer manufacturer, and a close competitor of Toshiba, began work on optical-disc computer storage at its Central Research Laboratories in 1978. Hitachi's work in the development of a miniature semiconductor laser diode gave the company an

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early advantage in the development of small DRAW systems. Hitachi is known to have in development a system for document storage much like Toshiba's. At its 70th anniversary stockholders meeting in early 1982, Hitachi showed a prototype of its DRAW system, but it has been among the most secretive of the major companies involved in optical-disc development.

Uses of Large Databases

Videodiscs probably offer the best medium for electronic printing and publishing due to their low reproduction costs and their text and graphics capabilities. Though some estimates place full electronic publishing as far as 15 years from now, there will surely be deep inroads made in this field within the next few years.

Many indexing and cataloging services could easily use optical discs as a distribution medium, as the information is usually in a computer to begin with. Literature and patent searches, for example, could be done with small computers. Businesses could have large demographic databases to aid in product marketing. Computer programs connected to large text and picture databases will give computer-aided education an added dimension. Special-purpose databases will be available at work or at home on a large variety of subjects.

It is difficult to predict future uses of any new technology, or even whether it will be used at all. We have heard, however, that the most valuable commodity in the near future will be information—and videodisc technology offers perhaps the least expensive method to produce, replicate, and distribute large collections of data. ■

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4. "Videodiscs: A Three-Way Race for a Billion-Dollar Jackpot." *Business Week*, July 7, 1980, p. 72.

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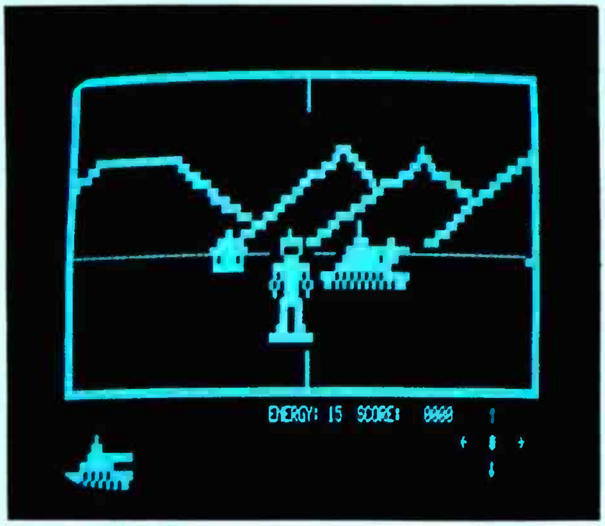

Photo 1: *The view from your tank turret. You can see both an enemy robot and a tank in the foreground, one of the houses that dot the battlefield, and in the distance, the mountain range that surrounds the plain of combat.*

When the assault cruisers first landed on this strange planet, you had no idea you would eventually find yourself commanding the last-surviving T-36 heavy-assault tank company in the entire sector. You have only a few tanks left, and transferring to a surviving tank is your only hope to keep fighting if your current tank is destroyed.

Suddenly, the targeting radar shows an enemy tank to the left, and the robot detector lights up. You fire but miss the tank. Oh no! The energy levels are dropping in your tank! The enemy robot has tapped your energy supply and is draining it. Wait, you have the other tank in your sights. You fire the T-36's high-energy plasma cannon. You got the tank. Now quick, spin and blast the robot before your energy is gone. Got 'em! And so the battle continues; you monitor the targeting radar and fight on against the alien foe.

Armored Patrol is one of the latest releases from Adventure International for the TRS-80, and it is a real winner. The game puts you in the commander's seat of an armored assault tank fighting an alien enemy on a hostile plain. The object is to destroy enemy tanks and robots with your tank's high-energy plasma cannon before they zap you. The enemy tanks can return fire with a similar plasma weapon. The robots drain your energy supply if they get close to you. You view the enemy and the surrounding planet surface through the T-36's viewport and locate the enemy via a direction finder at the lower-right side of the TRS-80 screen display.

The Game

The really outstanding feature of this game is its three-dimensional graphics (you will notice similarities to the popular arcade game Battle Zone). As you move, the screen image changes perspective relative to your movements. The closer you get to an object, the larger it appears and vice versa. When you spot an enemy tank or robot, it can and does move, and the movement also has perspective. For instance, if a tank moves across your view from left to right, it starts small, gets larger when it's directly in front of

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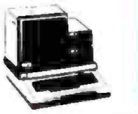

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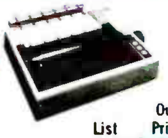

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At a Glance

Name
Armored Patrol

Type
Arcade-type game

Manufacturer
Adventure International
POB 3435
Longwood, FL 32750
(305) 862-6917

Price
$19.95, cassette;
$24.95, disk

Authors
Wayne Westmoreland and
Terry Gilman

Format
Cassette tape or 5¼-inch floppy disk

Language
Z80 machine language

Computer Needed
TRS-80 Model I or III with either 16K bytes (cassette version) or 32K bytes of memory and one disk drive (disk version)

Documentation
Self-documented program

Special features
Multiple-player option; sound-effects capability (requires an amplifier)

Audience
TRS-80 owners who enjoy arcade games

you, and then shrinks in size as it pulls away. The buildings also increase and decrease in size as you move in relation to them. It is all quite lifelike.

You control the movement of your tank via the keyboard. The "A" and "Z" keys control your tank's left tread; the ";" and "." keys control the right tread. Using them in combination, you can advance, retreat, and turn (slowly or rapidly) in either direction. The space bar fires your plasma cannon. The plasma "missile" will destroy the enemy if it hits but does not do any damage to the assorted buildings located on the planet's surface.

How to Score

Scoring is straightforward. Enemy tanks are worth 1000 points, and robots are 5000 points. For every 20,000 points you score, you get another T-36 tank as a reserve. If the enemy tanks hit you with their fire or the robots suck all your tank's energy out, you lose that tank. Hiding behind buildings and darting out to fire can be a good tactic. Remember that the robots materialize at random locations and don't appear on your scope, so you

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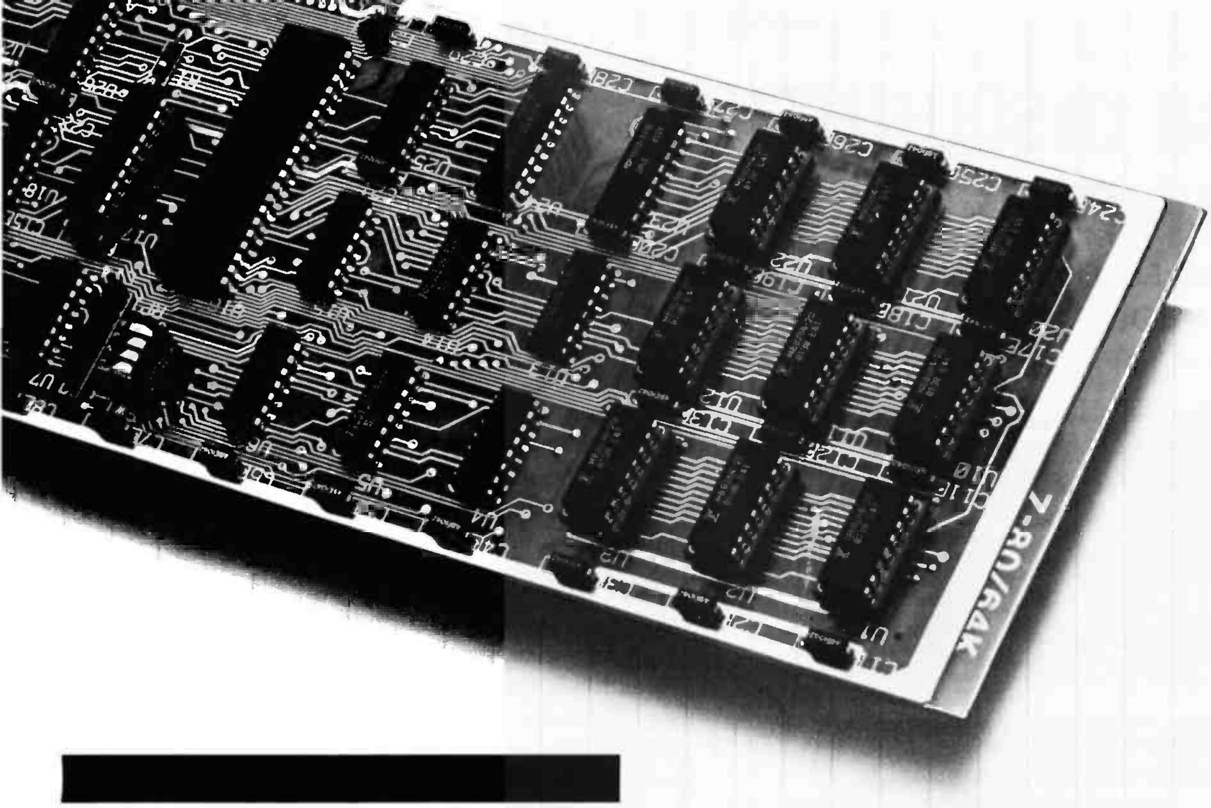

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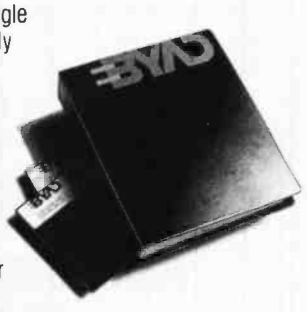

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must watch your energy levels. A significant drop means that a robot is in range. When you blast a robot and it shimmers out of existence, your energy reserves stabilize. The biggest problem is remembering to be aware of the robots as they sneak behind you and drain your tank's energy before you can turn around to blast them. You fight until you have exhausted all your reserve tanks. The game will display the top ten scores and save them to the game disk. After the final tank is destroyed, you begin again with your initial complement of tanks.

Action Graphics

Wayne Westmoreland and Terry Gilman, authors of Armored Patrol, did a really super job with the graphics. The action is smooth as you move across the planet's surface. For block-type graphics, the view is quite realistic. You could even imagine you're watching a computer-generated target display.

Other notable features are the use of real time, the tracking of the highest ten scores, and the option of one or two players. In the two-player mode, you alternate at the controls of the tank, and whoever gets the highest score wins.

Even though your score climbs after the first couple rounds, this is not an easy game. You have to keep moving, and if an enemy tank or robots get behind you or you take too long turning to attack, you lose tanks. You have to be a pretty good shot to hit the enemy, especially when you and the enemy are moving toward each other or in opposite directions. Who knows—it may even sharpen your eye if you do any bird watching or picture taking.

Conclusions

- Armored Patrol is a fast-paced, arcade-style action game that features three-dimensional graphics. It can be played on a TRS-80 Model I or Model III. The game is available on both tape and disk. Two players can compete during each round of play (players alternate turns).
- Scoring is straightforward. Novices and experienced game players should enjoy this one. The keyboard-controlled movement is simple to master, and the entire screen display is nicely done. Player instructions are actually a module in the game, so you don't have to worry about losing any instruction sheets.
- You won't find yourself getting bored with this game. The block-type TRS-80 graphics are quite adequate to convey the movement of your tank around the battlefield. The action is spirited and can become quite addictive.
- The price is a pleasant change when compared to the cost of many games.
- Overall, Armored Patrol is a well designed, nicely executed program, and I think you will enjoy it as much as I did.

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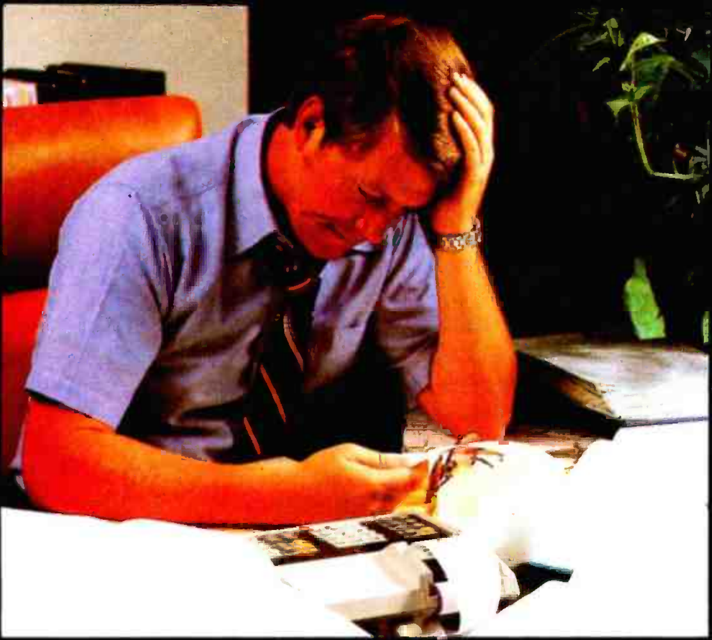

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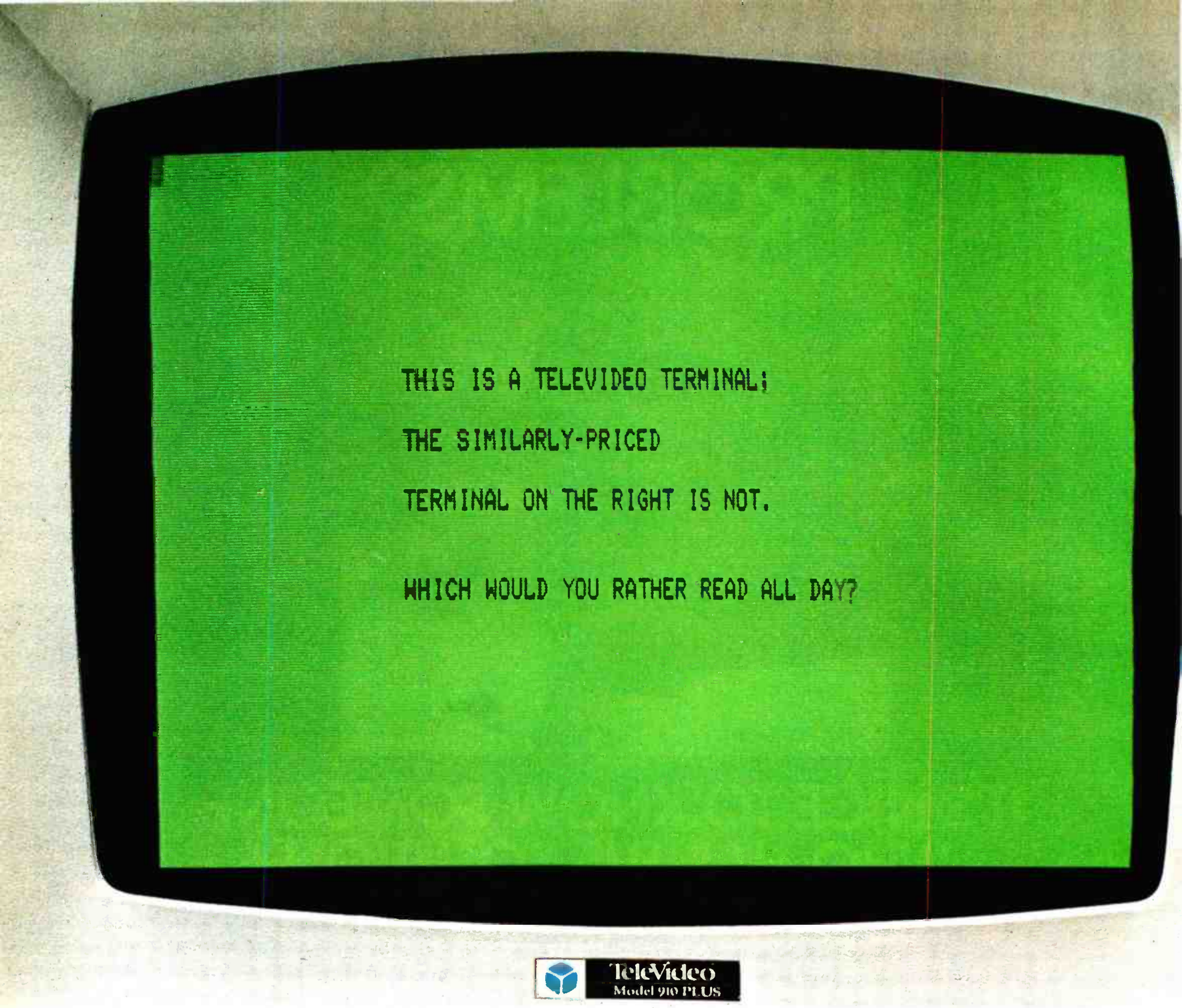

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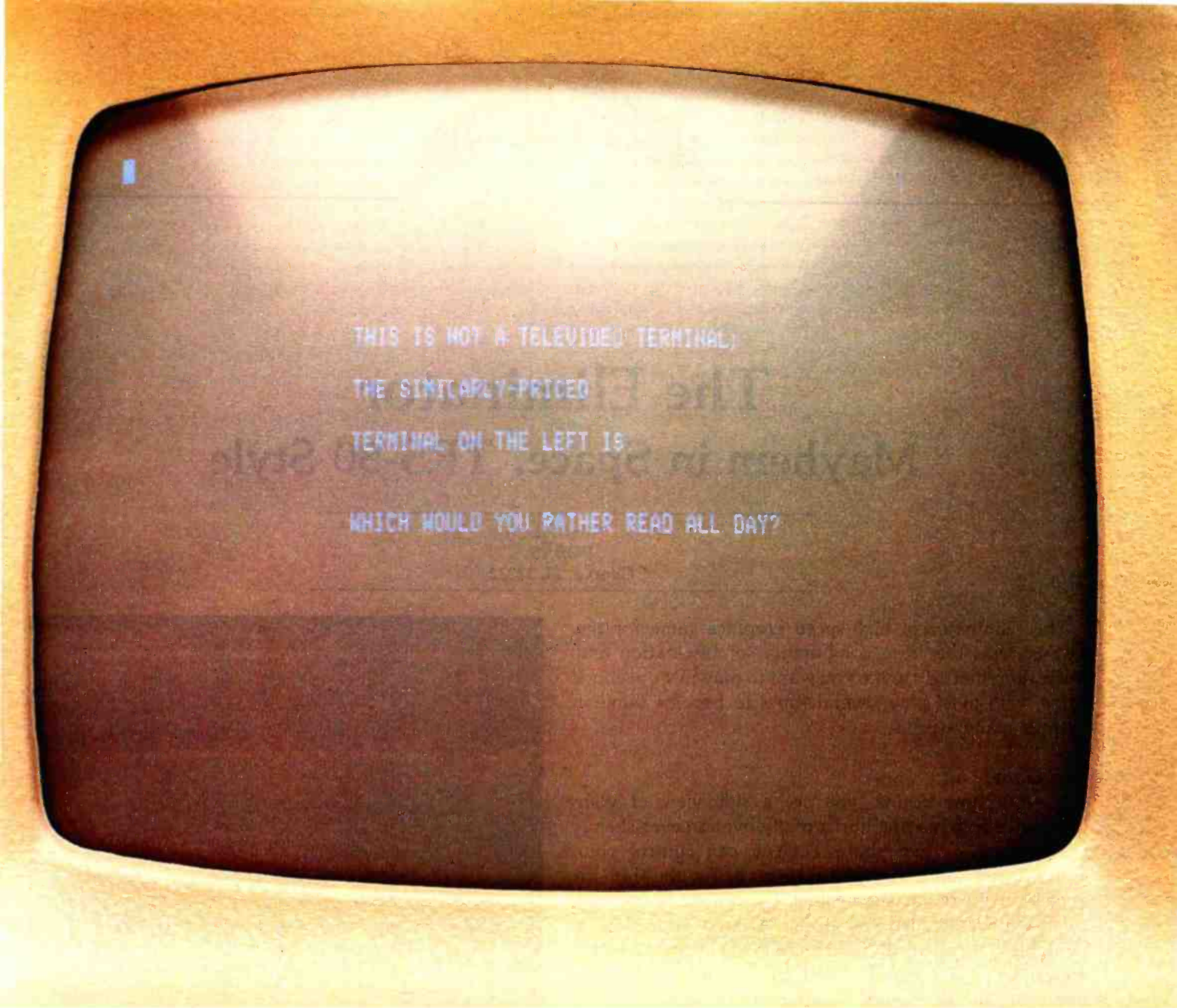

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BYTE'S ARCADE

The Eliminator

Mayhem in Space, TRS-80 Style

Silas Pike
POB 75
Geneva, FL 32732

The Eliminator, a high-speed graphics game for the TRS-80, has that rare combination of fascination and frustration that will make you want to play just one more game. You must play several times to become familiar with its many aspects.

The Game

As the game begins, you see a side view of your Eliminator ship moving horizontally over an ever-changing planetscape (see photo 1). You can control your craft's speed, altitude, and direction. Below the ship are gantry towers of varying heights. Upon these towers rest small cylinders called energizers. Around your ship, a veritable smorgasbord of alien craft exit hyperspace and appear on your screen. Of the four alien manifestations, one type, the *disruptoid*, is after your energizers. You must prevent the disruptoids from latching onto your energizers. If they reach the top of the screen with one of your energizers, they transmute into pulsating forms from which escape can be nigh impossible.

From an offensive standpoint, your Eliminator craft is equipped with an unlimited supply of plasma bursts. But once the airspace becomes very congested, you may have to rely upon your ultimate weapon—the *disruptor charge function*, which eliminates *all* enemy craft from the immediate area. Disruptor charges should be labeled "For Emergency Use Only" because you have just three per game. Once all ten of your energizers are captured or destroyed, the planetscape and gantry towers disintegrate in a blinding flash, thrusting your ship into the alien equivalent of 5 o'clock rush hour. Disruptoids swoop in for the kill, frequently in numbers so great as to completely overwhelm you.

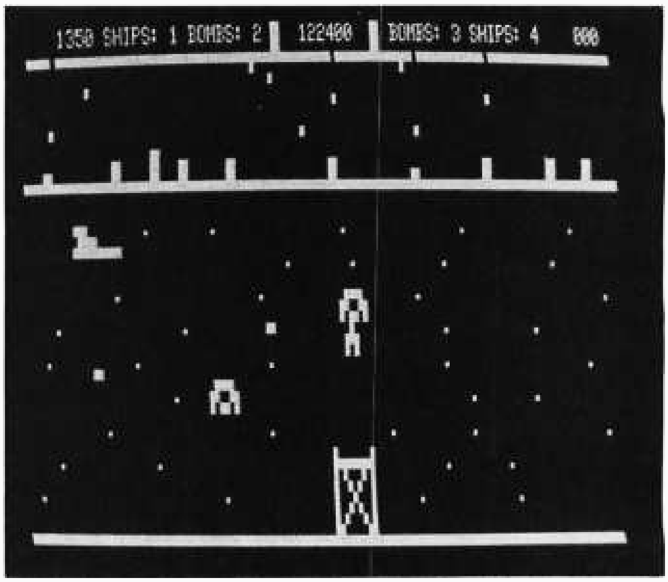

Photo 1: *A disruptoid ascends, energizer in tow, while a second disruptoid hovers below and to the left. Your Eliminator ship is to the left of both alien craft and above them. Note the wide-screen monitor at the top of the screen.*

Playing The Eliminator

You can take many different approaches in playing a good game of The Eliminator because this game poses the triple challenge of (1) accumulating points (by destroying alien craft), (2) staying alive, and (3) preventing the capture or destruction of your energizers. You may focus on any one of these three tactics and play a moderately successful game. But the big points don't come until you are able to synthesize all three.

For example, one maneuver that separates the novices from the pros is the recovery of an energizer from an alien ship that has latched onto it and is in the process of ascending. This maneuver requires a deft hand and a steady eye and is done in several stages. First, the disruptoid must be destroyed. At this point you have an option:

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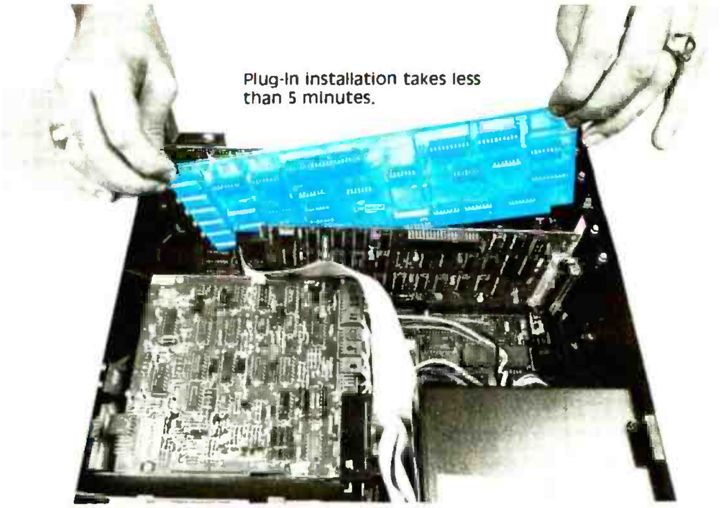

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Item	Point Value
Disruptoids	150
Drones	250
TDUs	1000
Tracers	150
Energizer save	250
Energizer replacement	500
Energizer interception	500

Table 1: *The point values for destroying enemy ships and for saving your energizers.*

At a Glance

Name
The Eliminator

Type
Arcade-type game

Manufacturer
Adventure International
POB 3435
Longwood, FL 32750
(305) 862-6917

Price
$19.95, cassette tape;
$24.95, disk version

Authors
Wayne Westmoreland and
Terry Gilman

Format
Cassette tape or 5¼-inch floppy disk

Language
Z80 machine language

Computer Needed
TRS-80 Model I or III with either 16K bytes (cassette version) or 32K bytes of memory and one disk drive (disk version)

Documentation
Pamphlet outlining key functions

Audience
TRS-80 owners who enjoy arcade games

either let the energizer fall slowly back into place upon its gantry pad (250 points) or maneuver your ship into contact with the free-falling energizer and replace it upon a gantry pad (500 points). Usually, this process requires several quick forward/reverse and up/down movements of your Eliminator craft. Once all ten of the disruptoid crafts have been dealt with, you will have a few seconds to relax while the screen displays the number of energizers remaining and designates the upcoming attack wave.

The second and subsequent waves consist of two types of alien craft: *drones*, which zigzag diagonally across the screen, and *TDUs* (Tracer Dispersal Units), which ascend and descend benignly until attacked, whereupon they discharge five small *tracer* craft which dip and dive with semi-intelligent abandon and change direction upon pursuit.

Points

Points are accrued for the destruction of enemy craft and for ensuring the safety of your energizers (see table 1). When you use a disruptor charge, all the other spacecraft in the immediate area will disintegrate, garnering the point values of each destroyed ship. A tactical maneuver such as blasting two TDUs, which in turn will release a total of ten tracers, and then triggering a disruptor charge will rack up a minimum of 3500 points. Anything in excess of 30,000 points can be considered a good game. Co-author Wayne Westmoreland reports a high score of 122,400 (see photo 1), most humbling compared to my modest 62,000 high.

Graphically Speaking

The Eliminator uses block graphics for most of the action. Interesting additions are the scrolling gantry towers and planetscape and a starfield backdrop, all of which serve to promote the illusion of true motion. Equally effective is the *wide-screen monitor* at the screen's top, which expands your forward/reverse view by the equivalent of about 2½ full-screen areas in each direction. This enables you to monitor what's ahead or behind, before it arrives.

The sound routines in The Eliminator are definitely a cut above those of most TRS-80 programs. However, I prefer to be a member of the "soundless minority"; blips and bloops make me nervous, so I usually play with the sound patch disconnected.

Possible Improvements

To be as fair as possible, The Eliminator does have two features that could stand improvement. First, the hyperspace control (Clear key) should be farther from the disruptor-charge control (Enter key). On occasion, I have detonated the disruptor charge by accident when attempting to use the hyperspace function. Second, it would be nice to be awarded an extra ship and/or disruptor charge after passing, say, 50,000 points, as a merit award.

Conclusions

- The Eliminator is a fast-paced arcade game that makes excellent use of the TRS-80's low-resolution graphics.
- The on-screen presentation is well done and the wide-screen monitor is a marvelous feature.
- The game requires both fast reflexes and strategic thinking to be played effectively.
- The Eliminator is the best thing to happen to the TRS-80 in a long time.

Editor's Note: *The Eliminator is also available as a full-color, high-resolution game for the Apple II. This version requires an Apple II or Apple II Plus, 48K bytes of memory, and one disk drive. The price is $29.95. . . .* **A.A.L.**

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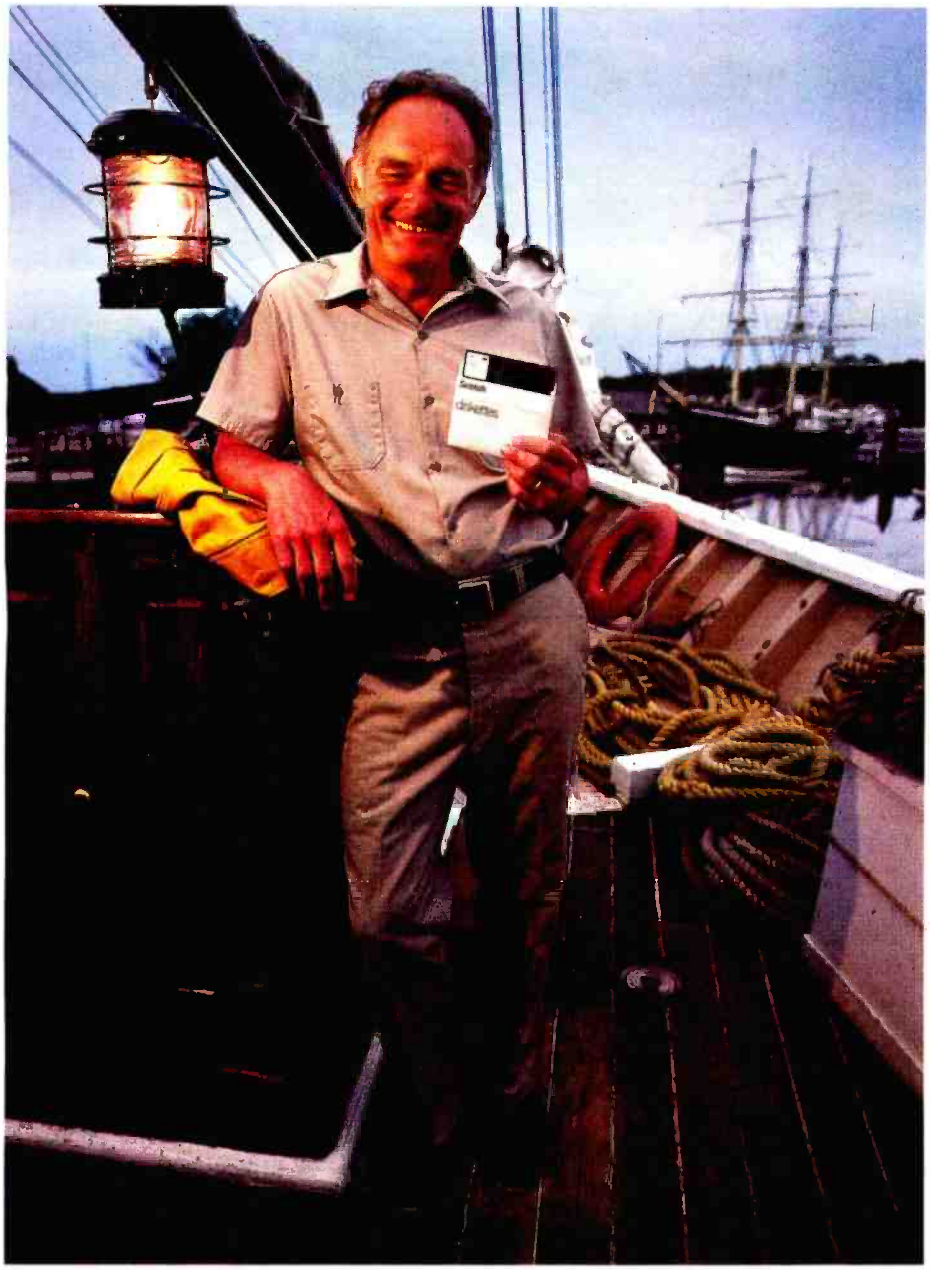

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Galactic Chase

Stan Wszola
Technical Editor

I have this recurring nightmare in which I'm trapped in a video arcade and forced to play the games endlessly. Unfortunately, all the games are identical. I suppose these dreams are the result of seeing too many arcade-game clones. It seems as if everybody and his brother is producing arcade look-alike games for the personal computer market.

Fortunately, Galactic Chase is no nightmare; it's an implementation of the successful Galaxians arcade game with some interesting variations.

Photo 1: *Screen display for Galactic Chase. Two of the alien ships are shown peeling off from the formation and moving in for an attack.*

The Game

Following the Galaxian theme, the object of the game is to shoot the alien ships. At the start of the game, a fleet of 36 alien ships appears, arrayed in ranks (see photo 1). The value of an alien ship depends on whether it is still in formation or moving in for an attack (see table 1). Not only is it more sporting to shoot them while they're moving, but they're worth more points then.

When the game begins, the aliens peel off from the formation and attack individually. Rather than make a straight descent toward the bottom of the screen, the aliens swoop and curve, raining their missiles upon you all the time. In flight, the aliens appear to be little gloves trying to grab your ship. The movement of the alien ships is very smooth and looks quite good on the screen.

Your Role

As the *Final Defender of Space*, you command three ships per game. Your ship is controlled by the Atari joystick, and you fire missiles by pressing the button. You can destroy the alien ships either by firing missiles at them or by having the aliens collide directly with the *magnetic repellers* at the front of your ship.

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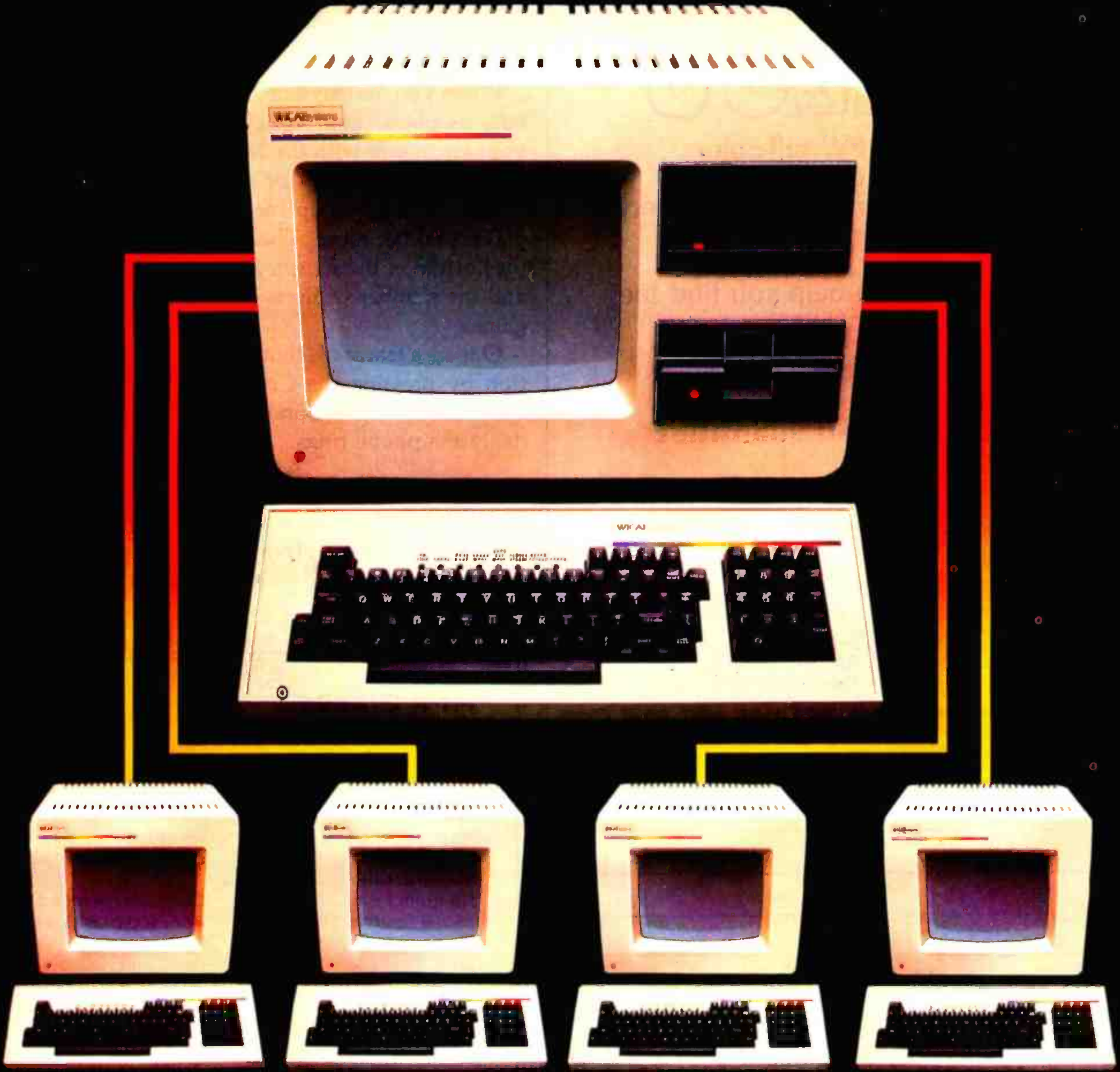

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Ships	Number	Point Value	Attack Value
Ensigns	20	20	40
Captains	7	30	60
Flankers	6	40	80
Command Ships	2	50	100 to 400

Table 1: *The variety, number, and point values of the ships in the alien fleets.*

In this game, there is nowhere to hide. You can't duck behind a convenient barricade. Your ship is out in the open, so the game requires a lot of movement to dodge the alien missiles and ships. The game is a true test of eye-hand coordination.

When you destroy one fleet of alien ships, another will take its place. You receive a bonus ship at the start of your encounter with the 16th, 32nd, and 48th fleets. You also get a bonus ship for each 7000 points scored.

The game is set up for one or two players, with the players taking turns. The current scores are displayed at the bottom of the screen, as are the highest score achieved and the number of fleets encountered from the previous game.

One nice feature is that you can stop and restart the action by pressing the Control-1 keys. This is especially convenient if the action becomes hot and heavy and suddenly the phone rings.

Options

The game has three levels of skill. After you have destroyed 10 fleets in level one, you are moved up to level two, where the speed of the aliens increases. At your en-

At a Glance

Name
Galactic Chase

Type
Arcade-type game

Manufacturer
Spectrum Computers
26618 Southfield Rd.
Lathrup Village, MI 48076
(313) 559-5252

Price
$24.95, cassette;
$29.95, disk

Author
Tony Weber

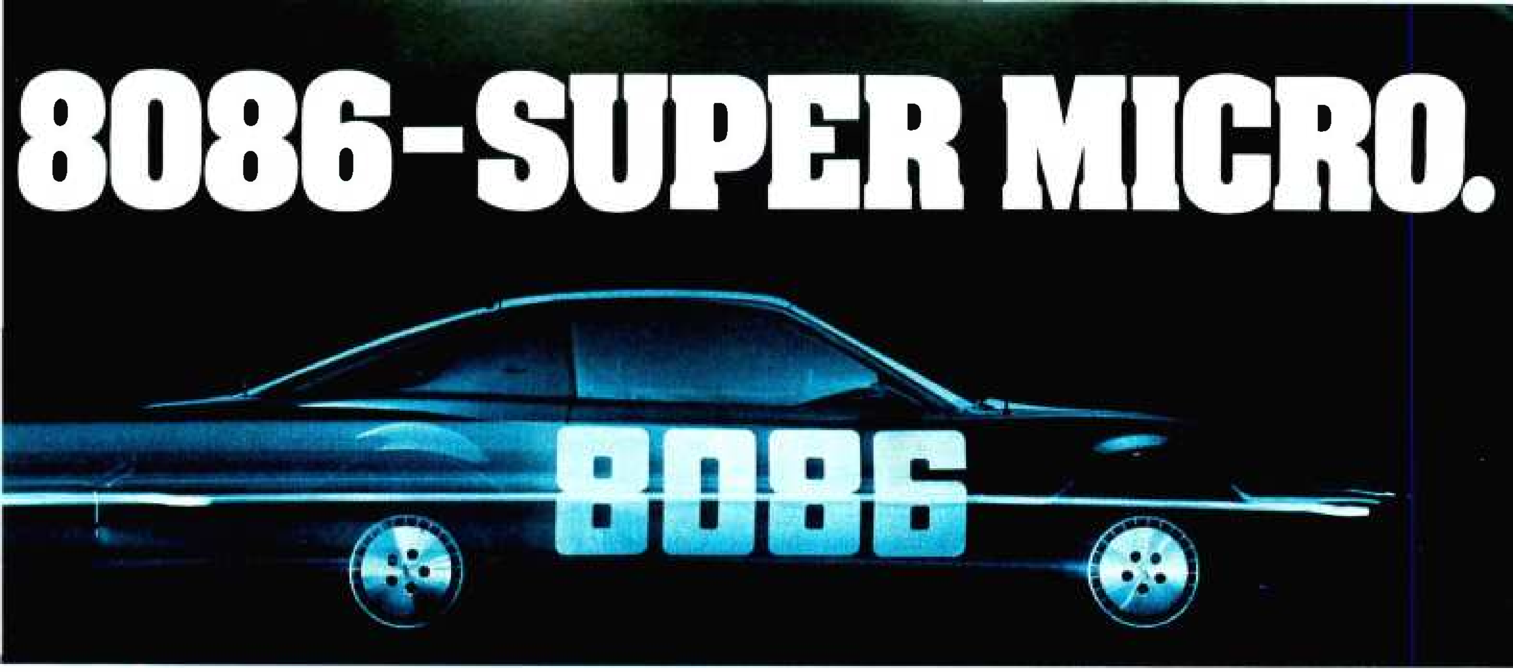
Format
Cassette tape or 5¼-inch floppy disk

Language
6502 machine language

Computer Needed
Atari 400 or 800 with 16K bytes of memory, one disk drive, and two joysticks

Documentation
One-page pamphlet

Audience
Game players



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Digital Equipment PDP 11/70	Mini	n/a	BASIC (I)	45
Prime 550	Mainframe	PRIMOS	BASIC V16.4 (I)	63
Digital Equipment PDP-10	Mainframe	TOPS-10	BASIC (I)	65
IBM System 34	Mainframe	Release 05	BASIC (I)	129
TEI System 48	Micro	MAGIC 1.0	Microsoft BASIC (C)	178
Hewlett-Packard HP3000	Mini	Time Share	BASIC (I)	250
Seattle Computer System 2	Micro	MS-DOS	Microsoft BASIC (I)	310
Alpha Micro AM-100/T	Micro	AMOS 4.3a	Alpha BASIC (SC)	317
Digital Equipment PDP 11/45	Mini	n/a	BASIC (I)	330
Data General NOVA 3	Mini	Time Share	BASIC 5.32	517
Ohio Scientific C4-P	Micro	OS65D 3.2	Level 1 BASIC (I)	680
North Star Floating Point	Micro	NSDOS	NorthStar BASIC (I)	685
Radio Shack TRS-80 II	Micro	TRSDOS 1.2	BASIC (I)	792
Apple II+	Micro	DOS 3.2	Applesoft II (I)	960
Cromemco System 3	Micro	CDOS	32K BASIC (I)	1074
Commodore Pet 2001	Micro	n/a	Microsoft BASIC (I)	1374
IBM 5100	Micro	n/a	BASIC (I)	1951
Vector MZ	Micro	n/a	Micropolis BASIC (I)	2251

*C = Compiler; I = Interpreter. Times (except for Seattle Computer) taken from August 1981 issue of Interface Age.

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counter with the 31st fleet, an *invisible ray* disables your missile launcher and slows the speed of your missiles. This is level three. You also have the option of starting at level two if you find level one too tame.

Strategy

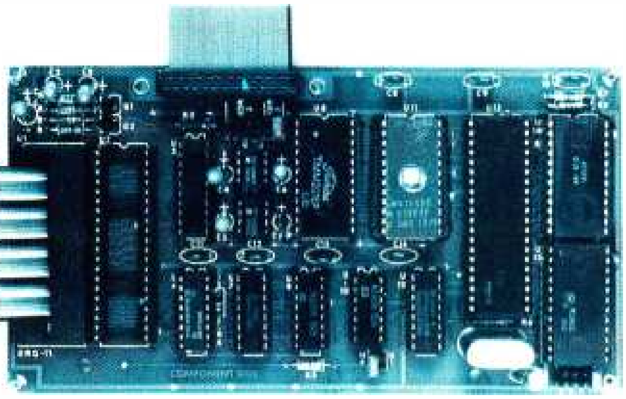
Conventional wisdom suggests that the safest approach is to shoot the alien ships one column at a time. However, another strategy is to destroy the alien ships only while they're in motion. You'll acquire more points if successful, but your ships will face the greatest danger. You might reserve this strategy for the command ships; one command ship can be worth up to 400 points. (The value is determined randomly and is displayed when you hit the ship.)

My usual modus operandi is to keep my ship in constant motion. I've found that if you concentrate on one specific target or column, it's easy to pick off ships. Also, the alien ships tend to follow the motion of your ship, so radical changes in direction will throw them off your track.

As I mentioned above, alien ships can be destroyed by ramming them with the front of your ship. The latter tactic is *not* for the fainthearted. Because the alien ships are firing directly ahead, you must wait till the last moment before placing your ship in the path of the alien. If the alien should touch the side of your ship, both ships will be destroyed. This tactic, therefore, is only for macho game players or for use as a last-ditch effort.

Conclusions

- I have only two complaints. I dislike the bursts of light in the background. Obviously meant to represent flickering stars, the effect looks more like cosmic dandruff. Also there is no software switch to turn off the sound effects. (My fellow editors did not appreciate hearing all of the galactic mayhem while they were trying to work.) These minor points become irritating if you play the game for any length of time.
- Galactic Chase is faithful to the original version. It offers an exciting game with a maximum of action and a minimum of complications. The graphics are smooth and colorful, and all information is nicely displayed. Galactic Chase is a natural for any Atari owner's game library. ■



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On the Way to Standard BASIC

A survey of what's in the proposed ANSI standard and why it's there.

Thomas E. Kurtz
Dartmouth College
Hanover, NH 03755

The American National Standards Institute (ANSI) committee X3J2, charged with developing a standard for the BASIC programming language, held its first meeting in January 1974. We're now well into the eighties and still we have no published standard. Why so long? The standardization process is at best slow and cumbersome, but need it be this slow? After all, standards for FORTRAN, COBOL, and PL/I have been around for a while. Half of the short answer is that the X3J2 committee has produced in eight years two standards: the "draft," which is the subject of this article, and Minimal BASIC, which appeared in 1978 (see reference 1). (Minimal BASIC has not caught on because the rapid development of chip technology has made its modest capabilities obsolete.) The other half of the short answer is that BASIC was changing drastically while the committee was trying to standardize it. In other words, BASIC has been a moving target.

BASIC got its start as a simple language designed to make life easier for the nonexpert programmer. But what started out as a simple language with no more than a dozen different statements dealing only with numbers has grown into a diverse language with many statements capable of handling numbers, strings, arrays, files, and plotting. Single-letter and letter-digit variable names have grown to multi-character variable names. Simple GOTOs and IF. . .THENs have evolved into the famous constructs of structured programming. Each vendor has developed its own formats and rules for these extensions so that present versions of BASIC differ widely as to form and content.

At long last, the diverging paths are being brought together in the new proposed standard for BASIC. The standard includes structured constructs, a "MAT" (matrix) package, formatted output, subprograms that can be made independent, files, exception handling, and optional sections on graphics, sophisticated file structures, real time, fixed decimal arithmetic, and editing. (Details appear later in this article.) The example in listing 1 illustrates a few of the highlights of standard BASIC: multi-character identifiers, subprograms, and several of the structured constructs.

The standard is currently (early 1982) under technical committee mail ballot, which will assert (if it passes) that the technical development of the standard has been completed. The next major milestone is a public-review period conducted by ANSI's X3 committee, which supervises the making of all computer-related standards in the United States. Further steps, which usually take several years to complete, will follow before the standard becomes ANSI official, but these are formalities that have little likelihood of changing the content of the standard.

The standard will mainly benefit the educational world. Programs published in magazines such as BYTE may eventually be in standard BASIC rather than in some variation. Textbooks containing programs won't have to be written specifically for a particular brand or model of computer. Finally, programs written in standard BASIC will be easier to transport and distribute.

Difficulties with Standardization

Developing a standard for BASIC has been difficult because the language serves such a diverse clientele.

Educational users tend to work on mini- and microcomputers. They desire a language that is easy to learn and is not cluttered with declarations or excessive structure. They would be satisfied with fairly simple file systems.

About the Author

Thomas E. Kurtz is co-author of the original, "Dartmouth" BASIC and is chairman of the ANSI committee that has developed the proposed draft standard for BASIC.

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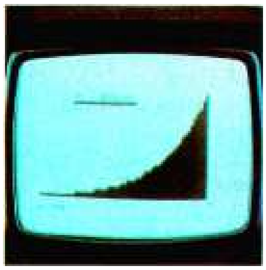

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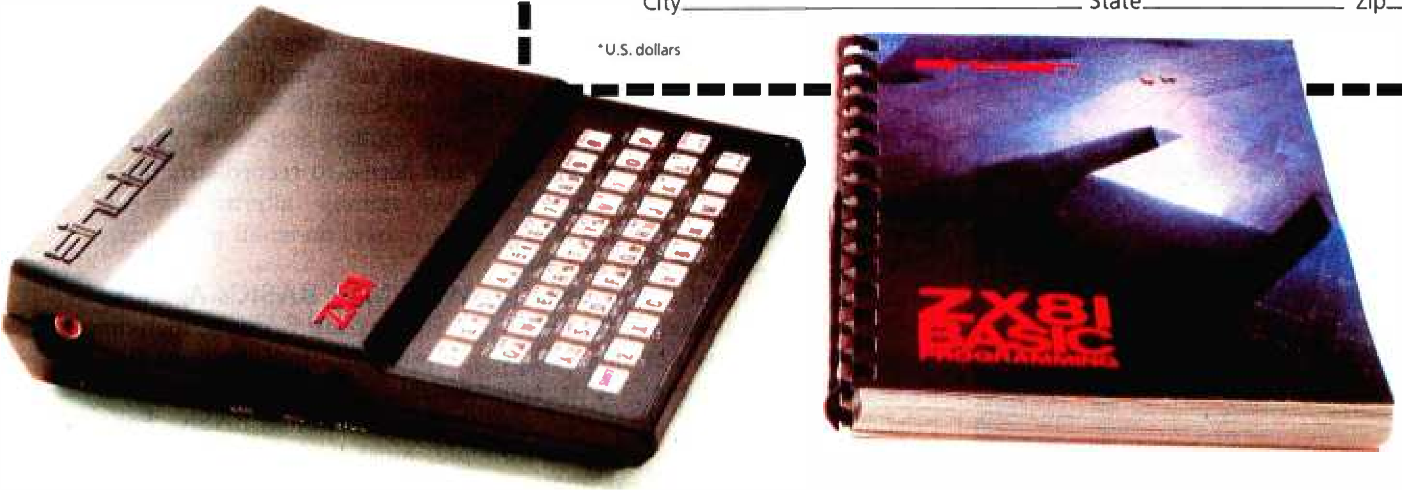

Listing 1: *This program incorporates many of the new features of the proposed draft standard for BASIC.*

```
100  Program CRAPS
110  !
120  ! A simple program in standard BASIC
130  !
140  ! Plays N games of craps
150  !
160  ! Read n
170       Data 10
180  !
190  For i = 1 to n
200       Call DICE (Total)
210       Print "You rolled a "; Total
220       Select Total
230       Case 7, 11
240            Print "You win."
250       Case 2, 3, 12
260            Print "You lose."
270       Case else
280            Print "which is your point."
290            Do
300                 Call DICE (Newtotal)
310                 Print Newtotal,
320            Loop until Newtotal = 7 or Newtotal = Total
330            If Newtotal = 7
340            Then
350                 Print "You lose."
360            Else
370                 Print "You win."
380            End if
390       End select
400  Next i
410  !
420  End
430  !
440  !
450  Sub DICE(Sum)
460  !
470  ! Roll two dice and add them up
480  !
490  Let d1 = Int(6*Rnd + 1)
500  Let d2 = Int(6*Rnd + 1)
510  Let Sum = d1 + d2
520  !
530  Sub end
```

Another group of users includes those with large machines or with access to large machines. These users want a rich, compiler-based language. They want to construct subroutine libraries of independently compiled subprograms. This group also wishes to write interactive programs that process strings of characters, something that FORTRAN and COBOL don't do easily. (PL/I allows string processing, but it's not accessible in many interactive environments.) Pascal does not offer what these users want either; it is too pristine.

A third group of users wishes to do business and financial calculations using BASIC. Such use is extensive partly because many of the early financial applications were written in BASIC. In Europe, BASIC is the primary business data-processing language for small computers. This group wants formatted output, accurate dollars-and-cents calculations, and access to record-structured files. Few suitable alternatives exist for these users on small machines.

What Most BASICs Are Like

Present-day BASICs, including the current version of the draft standard, reflect most of the goals of the original version of BASIC. For example, most BASICs avoid declaration of variables, with the notable exception that many, including the draft

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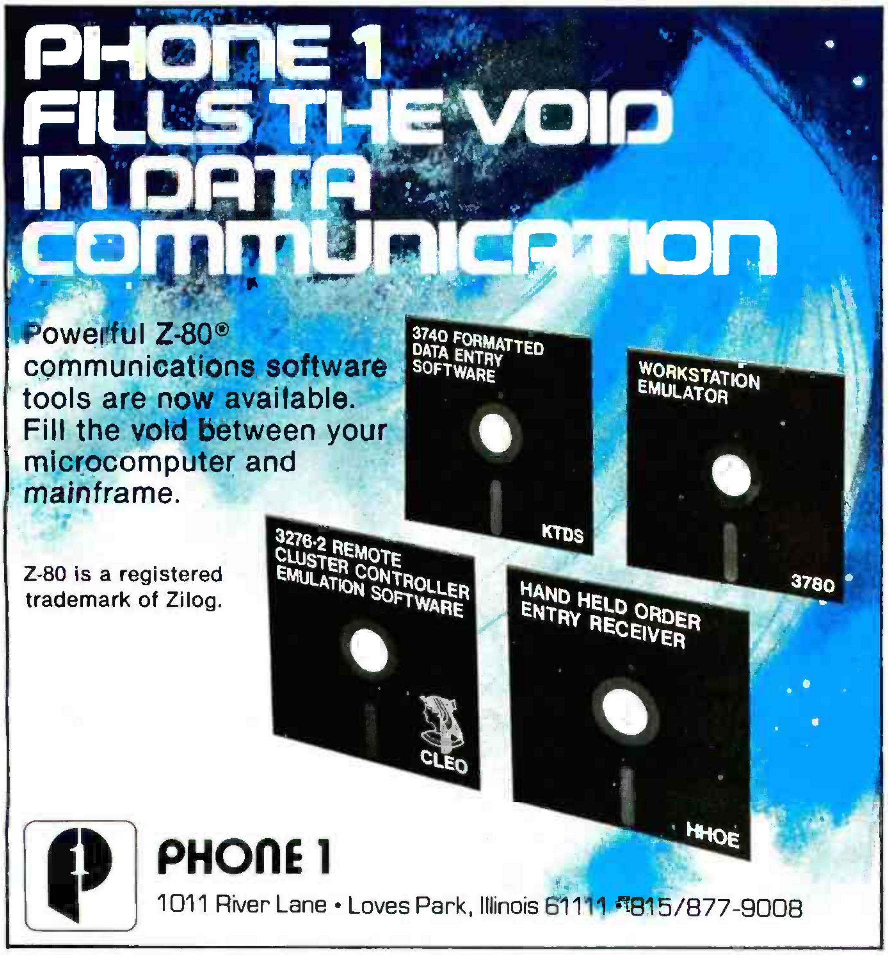

Timetable for Approval

This article is the first public presentation of the main features of the standard now in preparation. The X3J2 committee will shortly send its proposed standard to the parent committee X3. X3 will then establish a public-comment period during which copies of the proposed standard will be available. The public is then invited to examine the standard, point out flaws, or propose modifications. Individual computer users and user groups should be on the lookout for the public-comment period and respond with suggestions or comments.

We also hope that the trade and academic press will examine the standard when it becomes available and draw comparisons between it and other popular versions of BASIC. The X3J2 committee doesn't really expect all vendors to implement all that is in the standard. But we hope that what vendors do implement will be compatible with the standard.

The schedule of events in the near future for the standard is:

Late July 1982: *Confirm the technical review, possibly make last-minute changes.*
Fall 1982: *Transmit the standard to X3 for further processing. At this point, the standard will be virtually stable, and vendors and users can begin to count on its features. Subsequent processing of the standard is largely formal, although it is possible to change the standard when there is a significant public aversion to some feature in the standard.*
Late 1982 or early 1983: *Public comment period and letter ballot within X3.*
1983: *Transmittal to ANSI for still further processing.*
1983: *Final approval by ANSI.*

As with any best-laid plans, unforeseen problems can only cause delays. The above schedule is therefore optimistic. On the other hand, the technical content of the standard is not likely to change after the fall of 1982. Implementers should be able to plan new compilers and interpreters with confidence at that time.

standard, require declaration of arrays (lists and tables). In most BASICs, variables are typed implicitly, according to some special symbol. Thus, string variables have the dollar sign ($) in their name. This convention limits the number of different types of variables, because there aren't many special characters left. Some argue that this is good, not bad.

It is still true that a small job requires only a small program. Some BASICs even allow omitting the END statement. A language that lacks declarations and excessive structure lends itself more readily to interpreters. For these, a simple computation requires but a single statement. If you want to add 2 and 2, the single direct statement:

```
PRINT 2 + 2
```

will work. Try this in Pascal or FORTRAN!

Because a user can get by with a minimum of syntax rules and structure, BASIC is easy for novices to learn. Perhaps even more important, it is easy for occasional users to remember. I know teachers who use the computer only twice a year but who can remember what to do without having to check the manual.

The Proposed Standard

The standard will of course embrace most of simple BASIC or Minimal BASIC. (ANSI Minimal BASIC is similar to the earliest versions of BASIC. It includes the REM, LET, INPUT, PRINT, READ, RESTORE, DATA, DIM, FOR, NEXT, IF. . . THEN, line number, GOSUB, GOTO, RETURN, ON. . .GOTO, RANDOMIZE, single-line DEF, STOP, and END statements. It lacks string lists, files, plotting, etc. ANSI Minimal BASIC is quite minimal!) BASIC extends Minimal BASIC in a number of ways, for example, by allowing multicharacter variable names. It also includes features completely missing from Minimal BASIC, such as graphical output and real time. Incidentally, the committee elected to use the name BASIC for this standard. It had used the terms "Extended BASIC" and "Enhanced BASIC," but it dropped the modifiers, thus allowing their use by vendors later.

The standard is written so as to define *standard-conforming programs*. Any program that is written according to the rules of the standard is standard-conforming. A standard-conforming *implementation* (interpreter or compiler) is one that will correctly process a standard-conforming program. A standard-conforming implementation may offer extensions, provided that all standard-conforming programs will continue to be correctly processed. This point is important in order to understand some of the choices made by the committee.

Actually, the standard will consist of a core module plus five optional modules: enhanced files (direct access and keyed); graphics; real time; fixed decimal (for business users); and editing.

I'll now give a section-by-section summary of the features of the proposed standard.

Data Types

BASIC includes variables and constants of type numeric and string. Numeric is, of course, single precision. The standard will not specify other types, such as integer or double precision, both of which have been requested by part of the user community. It will provide fixed decimal but only as an option. The reason for not including other types is that BASIC serves many masters—large machines, small machines, microcomputers, interpreters, compilers, education, business—making the choice of data types difficult. As it is, vendors can enhance their own versions of the standard BASIC with whatever additional data types are needed by their users. Of course, programs written to take advantage of such data types will not be standard-conforming and might not be transportable.

Program Comments

In addition to the REM statement

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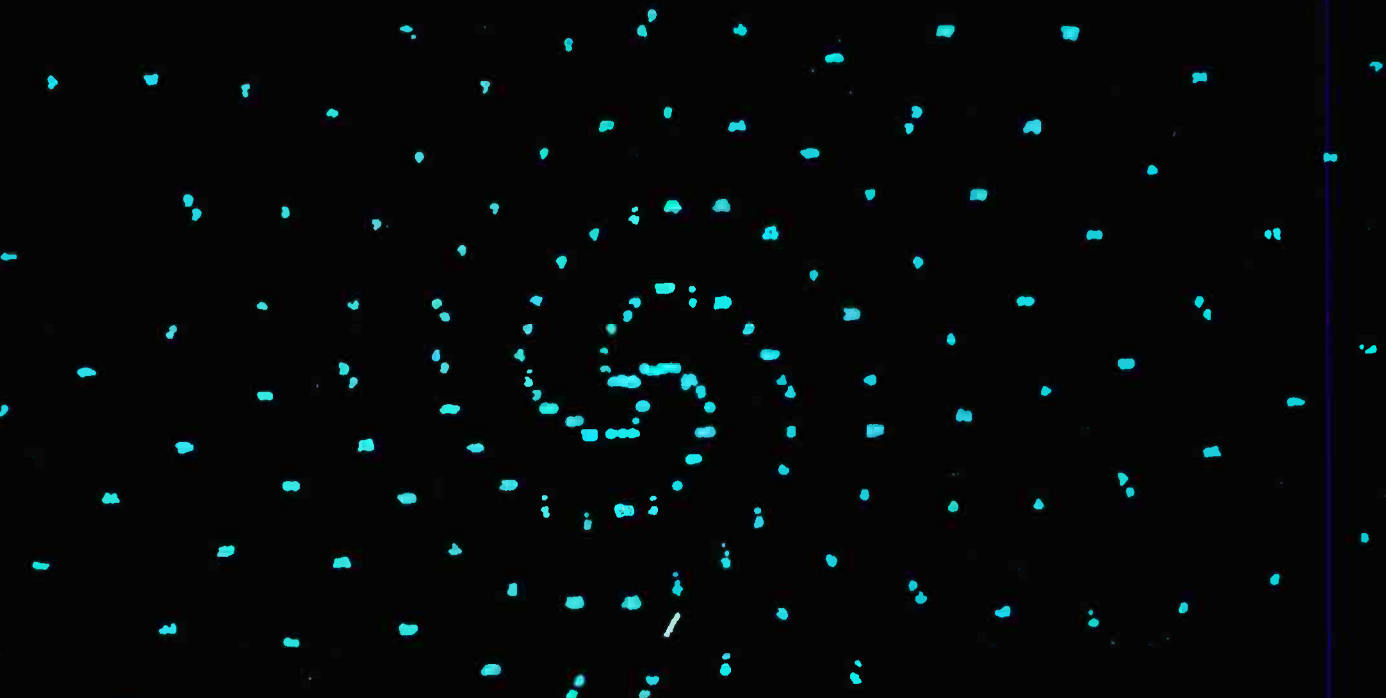

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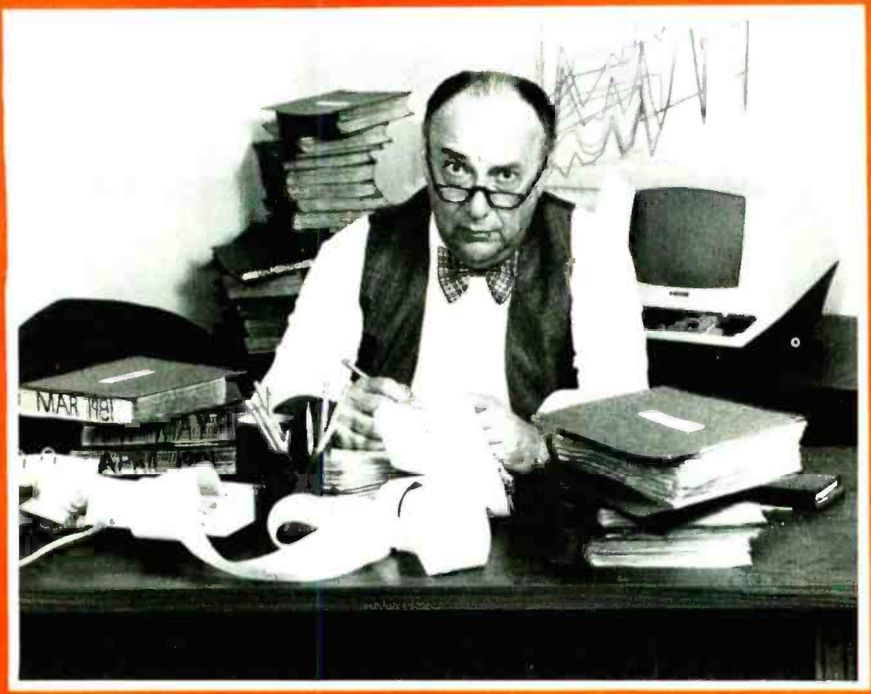

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for comments, BASIC will allow on-line comments using the exclamation point (!).

Identifiers

It did not take the committee long to vote for multicharacter variable names. Up to 31 characters (letters, digits, and underlines, starting with a letter) are permitted for variable and function names, with the trailing dollar sign for string-variables counting. Despite the obvious advantages over old-fashioned BASIC variable names, multicharacter names exact their price. For instance, spaces are required around keywords (such as FOR N = 1 to M instead of FORN = 1TOM), and certain words cannot be used as variable names (mainly, the names of the functions with no arguments, such as RND). The first restriction is probably a good idea anyhow. The second poses a challenge to implementers to come up with reasonable error messages when unsuspecting novice users try to assign one of these words as a variable name.

Incidentally, uppercase and lowercase may be used interchangeably for keywords, identifiers, function names, etc. Of course, the cases remain distinguishable in quoted strings, input replies, etc.

Numeric Operations

The big news is that arithmetic will be floating decimal. Thus, 2.29 + 4.71 = 7.00, not 6.999999. Also:

$$\begin{aligned} &.1 + .1 + .1 + .1 \\ &+ .1 + .1 + .1 + .1 \\ &+ .1 + .1 = 1 \textit{ exactly} \end{aligned}$$

Vendors may offer native arithmetic (presumably floating binary or floating hexadecimal) as an option if efficiency is an issue. But users will finally be able to carry out dollars-and-cents calculations with confidence.

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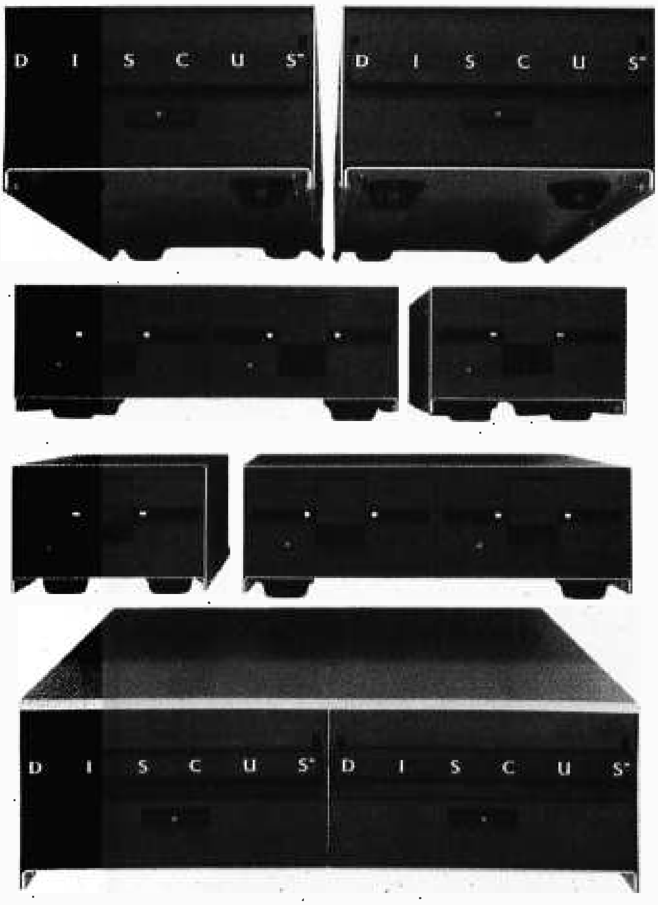

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Taking a cue from the hand-held calculators, the user at his option can express angles in degrees instead of radians. Secondary school trigonometry and general math students should benefit because normally students don't learn radian measure until they take calculus.

String Operations

The two important operations on strings are concatenation (joining two strings) and substring extraction. The former is accomplished by using the ampersand (&); the latter is achieved by following the string variable with a range enclosed in parentheses. Thus, LINE$(4:7) gives the fourth through seventh characters of the string LINE$. This substring notation can appear on the left side of a LET statement, in which case the fourth through seventh characters are replaced by whatever appears on the right side of the LET statement. The old substring functions (SEG$, MID$, LEFT$, etc.) that we have come to know and love are gone. Good riddance!

Functions whose arguments or values are strings include CHR$, DATE$, LEN, LCASE$, ORD, POS, STR$, TIME$, UCASE$, and VAL. CHR$ and ORD are opposite, and associate a character to its numerical value. LCASE$ and UCASE$ are lowercase- and uppercase-conversion functions. DATE$ and TIME$ give the date and time as strings. STR$ and VAL are the number-string conversion functions that have been around for a while in BASIC. LEN gives the length of a string. POS searches a string for another string.

LET Statement

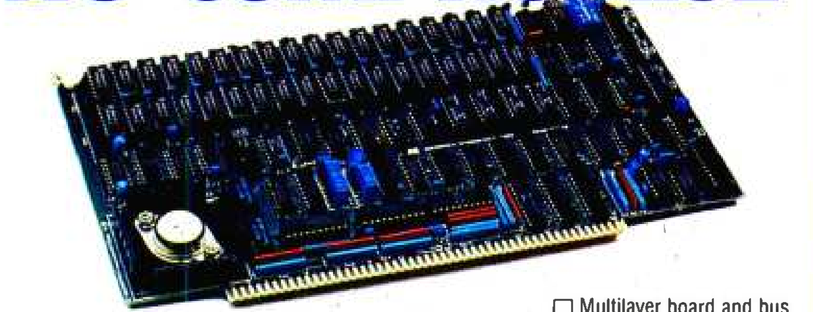
This brings us to a point that may disturb many. The LET in the LET statement is mandatory! One might ask why, as the option to omit it is such a common convention and a convenience to many users. The principal reason was to reduce the number of reserved words while retaining simple parsing. As it is, only the no-argument function names like RND and the words NOT, PRINT, REM, and ELSE are reserved (not allowed to be used as identifiers). This means that a user cannot write LET RND = 3. One should realize, however, that the standard actually prescribes only that *standard-conforming programs* may not omit the LET. Compilers and interpreters may, however, allow users to omit the LET, but they must accept the LET when it is present. Such implementations will have to be smart enough to recognize that:

```
INPUT = 3
```

is a LET statement and not an input statement.

Arrays

Arrays must be dimensioned in the program before use. This rule conflicts with Minimal BASIC, which allows default dimensions for lists and tables (vectors and matrices) that do not appear in DIM statements. You might wonder why we are doing away with the convenience of not having to dimension small arrays. The reason is that general identifiers are now allowed for both arrays and functions. For example, in "LET X = A(3)" the meaning of A(3) is



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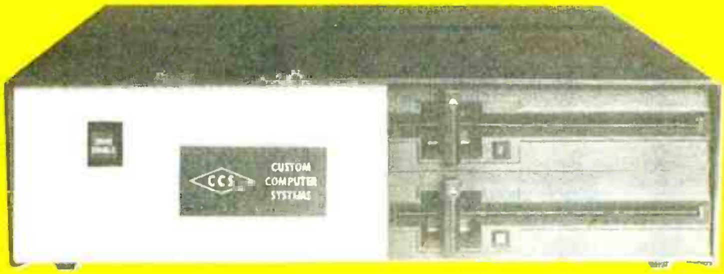

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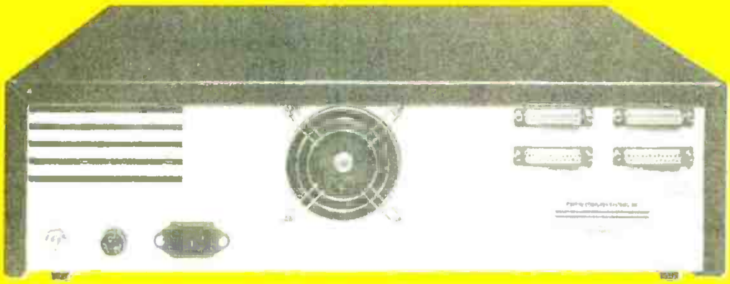

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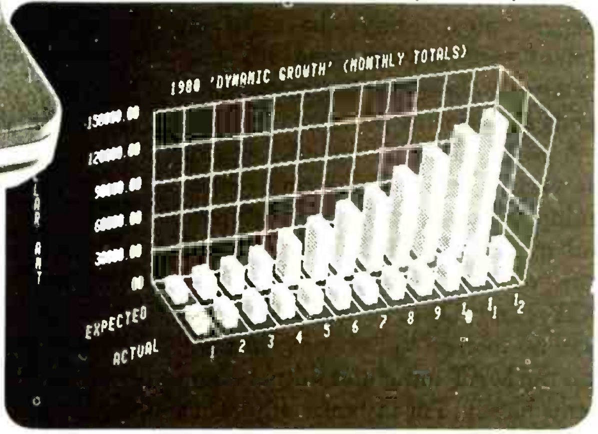

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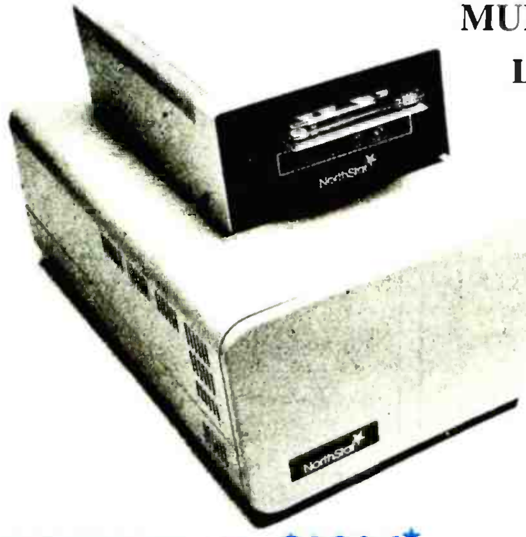

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ambiguous because it could be either element 3 of the array A, or the function A evaluated at 3.

There are three ways out of the dilemma. First, a two-pass compiler (or intepreter that does a pre-scan) could assume that A(3) was an array if it didn't find a function definition for A later in the program. Second, one could require that all functions be declared early in the program. Third, one could require that all arrays be declared early in the program. The committee adopted the third option because most arrays have to be dimensioned anyway and it's customary to place the dimension statements early in the program.

A MAT package includes matrix (or vector) input and output, scalar multiplication, matrix add, subtract, and multiply, and the matrix functions of linear algebra INV, TRN, DOT, and DET. Even those who have no interest in linear algebra will find the MAT input and output statements handy. For instance, suppose a small firm has several departments, and that the sales results for all of them are kept in several lists (one-dimensional arrays). Then:

```
MAT net__sales =
      gross__ sales − expenses
```

will calculate the net sales for all departments at once. (The above statement, and others like it later in the article, is intended to occupy a single line.)

Only one- and two-dimensional arrays are included in the standard, though designers of interpreters and compilers may choose to allow more.

Logical Expressions

Minimal BASIC allows only simple relational expressions (such as X < = Y) in IF statements. BASIC allows these to be combined using AND, OR, and NOT to form logical expressions. Parentheses are allowed, in case you forget whether AND takes precedence over OR or vice versa. Whereas Minimal BASIC allows only = and < > with strings (as with IF A$ = "YES"), BASIC allows the full range of relational operators with strings. What actually happens when "IF A$ < B$" is used depends on the collating sequence. For instance, the ASCII collating sequence specifies that "B" comes *before* "a".

Branching and Decision Making

The programmer can continue to use GOTO and IF. . .THEN from Minimal BASIC. Or instead he can choose to use structured constructs now typical of almost all programming languages. Take, for instance, the IF. . .THEN. . .ELSE construct. In BASIC, this takes the form:

```
IF <logical expression> THEN
. . .
ELSE
. . .
END IF
```

Two important features of this construct are, first, the keywords that define the construct must appear at the beginning of separate lines. Thus, the ELSE and END IF cannot be obscurely buried near the end of a line. Second, the construct ends with a keyword sequence that is unique to that construct.

You can use the simple one-line IF. . .THEN. . .ELSE, which might look like this:

```
IF x < y THEN LET a = 3
   ELSE LET a = 4
```

With both forms of IF. . .THEN . . .ELSE, the programmer may omit the ELSE part.

Looping Structures

The FOR NEXT loop of Minimal BASIC is retained, and a new structure, the DO LOOP, is added. The loop-ending condition (or conditions) may be attached to the DO statement, the LOOP statement, or both. The loop-ending condition may be expressed either as a WHILE or as an UNTIL. The following is typical:

```
DO UNTIL i > n OR a$ = list$(i)
. . .
LOOP
```

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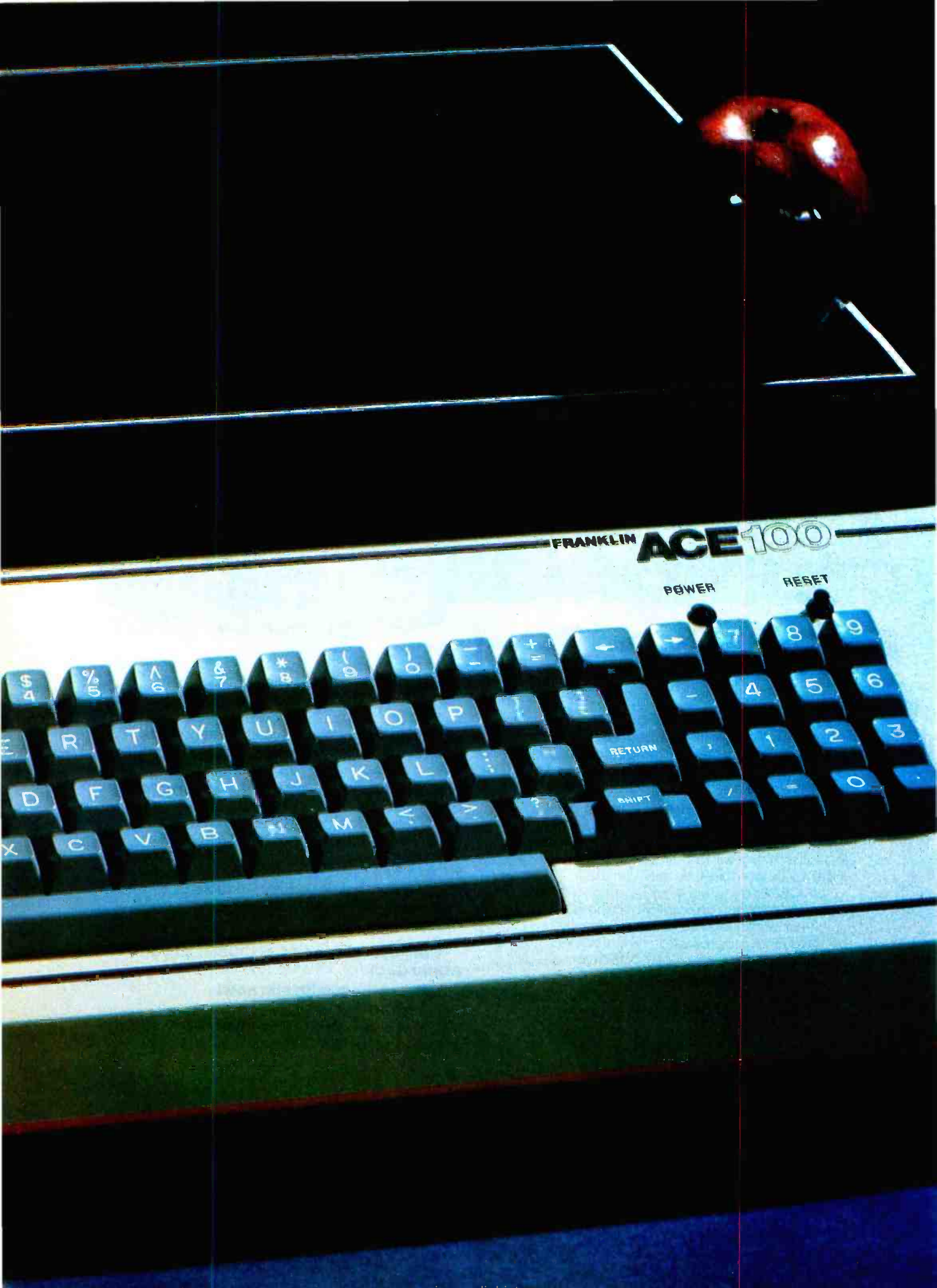
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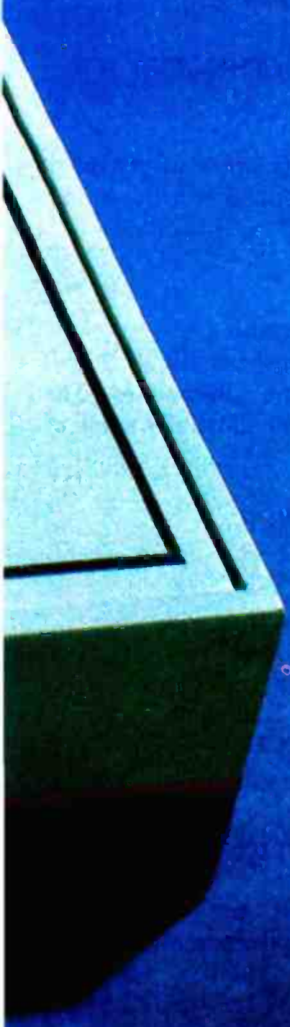

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In addition, a DO LOOP may be *exited* with an EXIT LOOP statement. Whenever such a statement appears in the body of a loop, the next statement executed will be the one following the first LOOP statement encountered. The following example is typical:

```
DO
  PRINT "Input an integer ";
  PRINT "between 1 and 7";
  INPUT x
IF 0 < x AND x< =7 AND
     x = INT(x) THEN EXIT DO
  PRINT "Bad number; reenter"
LOOP
```

The EXIT DO gets you out of a DO LOOP. Similarly, an EXIT FOR gets one out of a FOR NEXT loop. The previous example of the DO LOOP for searching a string list could also be written:

```
FOR i = 1 TO n
  IF a$ = list$(i) THEN EXIT FOR
NEXT i
```

Exit statements are also provided for multiline defined functions and subprograms.

Multiway Selection

A SELECT construct allows choosing one of many alternatives. The following example illustrates some of its features:

```
SELECT DICE
CASE 7, 11
  PRINT "Win"
CASE 2, 3, 12
  PRINT "Lose"
CASE ELSE
  PRINT "Roll again"
END SELECT
```

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tions, subprograms, and the ability to chain. Multiple-line defined functions begin with a DEF statement and end with an END DEF statement. In between, there can be any code, but there should be at least one LET statement having the name of the function on the left side.

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Input and Output

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case the string includes all characters between the quote marks including possible leading and trailing spaces. If the string data contain no leading or trailing spaces, commas, or quote marks, they may be unquoted.

The INPUT statement works as in Minimal BASIC. Inputting an entire line without regard to commas and leading and trailing spaces is done with the LINE INPUT statement.

Input-prompt strings other than the "?" can be provided. In addition, timeout control can be added. The following example is typical:

```
INPUT PROMPT "Answer = ",
    TIMEOUT 5, ELAPSED t:
    answer
```

As in Minimal BASIC, PRINT statements may use the comma to move to the next print zone, the semicolon to stay where you are, and the TAB function to move to a specified columnar position. BASIC provides, in addition, a PRINT USING statement for more elaborate output formatting. The image, which is like a picture of the eventual printed line, can be contained in a string or in an IMAGE statement referred to by its line number. The alternate forms of the PRINT USING statement are:

```
PRINT USING format$: . . .
  or
PRINT USING 100: . . .
```

Array input and output are also included. Variable amounts of input can be received by the statement:

```
MAT INPUT A(?)
```

Files

BASIC provides for four types of file organization: sequential, stream, relative, and keyed. Sequential files consist of records that must be accessed sequentially. Stream files consist simply of a stream of values and must also be accessed sequentially. Relative files are sometimes called random-access files; they probably will exist on disks. Keyed files are accessed not by record number but by some key.

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Three types of records are described: display, internal, and native. Display records are produced by PRINT statements—strings of characters ending in a carriage return-line-feed. Internal records contain values of numbers or strings, but in some internal format. The key point is that what gets read back in is exactly identical to what was written out. (This is not necessarily true with display-format files, as numbers must be converted to strings of characters on output and from strings of characters back to numbers on subsequent input.)

Of the 12 combinations of file organization and record type, only 3 are required in the core standard: sequential-display, sequential-internal, and stream-internal. Five other combinations are defined as possible enhancements. The remaining 4 are not defined by the standard, which leaves open the possibility that some implementations may use them.

The OPEN statement associates a channel-setter of the form "#13" to a file whose name is given. Ways are provided to find out if a file exists, and if it does, what its attributes are. The CLOSE statement closes a file. The ERASE statement erases the contents of a file and leaves it of zero length. Two examples:

```
OPEN #infile: NAME "Myfile",
        ACCESS INPUT,
        ORGANIZATION
        SEQUENTIAL

OPEN #3: NAME "filename"
```

In the second example, it is assumed that the organization is sequential; the record-type, display; and the access, "outin" (both input and output).

PRINT and INPUT are used to pass information to and from sequential-display files, just about the way they work for the terminal. READ and WRITE are used to communicate with all three file types. Display files can thus be accessed by both PRINT and INPUT, and READ and WRITE. Native-format files are accessed through "templates" and are provided for possible access to COBOL files.

Exception Handling

The construct for intercepting exceptions (situations during execution that usually cause the program to terminate) is:

```
WHEN EXCEPTION IN
  . . .
USE
  . . .
END WHEN
```

The following simple example can be used to protect against an invalid VAL argument:

```
LET flag = 0
WHEN EXCEPTION IN
  LET x = VAL(a$)
USE
  PRINT "Bad number; reenter"
  LET flag = 1
END WHEN
```

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The USE part is invoked when any exception whatsoever occurs during the WHEN part. In the previous example, it is almost true that only one kind of exception is possible. The printed error message will thus be correct most of the time. The programmer may double-check by using the EXTYPE function, which returns the coded number of the exception. For the example above, the EXTYPE value is 4001. Some 144 exceptions are defined and coded in the standard.

A CAUSE statement can force any particular exception.

More elaborate exception handlers may be constructed. For such purposes there are the RETRY, CONTINUE, and EXIT HANDLER statements and the EXLINE function. RETRY sends control to the start of the line in which the exception occurred, CONTINUE sends control to the line following that in which the exception occurred, while EXLINE has as its value the line number of the line in which the exception occurred. There is also a CAUSE statement that can force any particular exception to occur; a programmer can use the cause statement to check his exception-handling code.

Graphics

The language includes statements to carry out simple plotting. The basic plotting statement is PLOT. It can be used to plot dots or straight lines. As examples:

```
PLOT X,Y
PLOT X1,Y1; X2,Y2
PLOT
```

If the beam is off, the first plots a dot at (X,Y), and the second draws a line from (X1,Y1) to (X2,Y2). If the beam is on, the first and second also draw a line from the previous point to (X,Y) or (X1,Y1), respectively. The third turns the beam off (lifts the pen) if it's on and does nothing if the beam is off.

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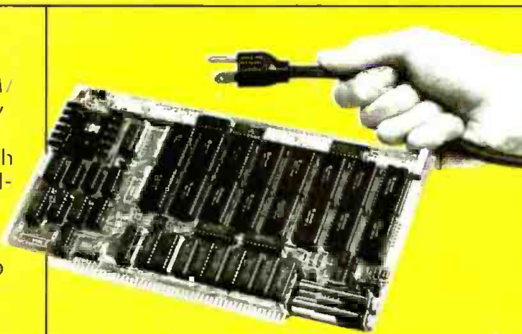

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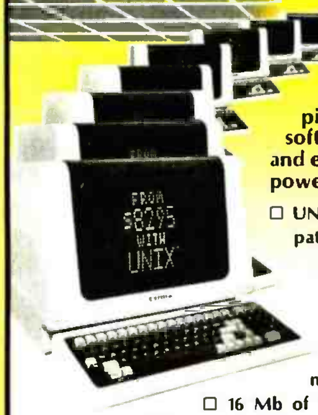

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Listing 2: *A graphics program written in the proposed draft form of standard BASIC.*

```
100  ! Town
110  !
120  ! Draws a picture of a town
130  !
140  ! Naming the type of plotter is implementation-defined
150  !
160  Window 0, 4, 0, 3
170  !
180  Plot Town
190  !
200  End
210  !
220  Picture Town
230  !
240      For i = 1 to 2
250        For j = 1 to 3
260          Plot House with scale(.5) * shift(i,j)
270        Next j
280      Next i
290  !
300  End picture
310  !
320  Picture House
330  !
340        Plot 0,0; 0,1; 1,1; .5,1.5; 0,1; 0,0
350  !
360  End picture
```

The points to be plotted are given in user coordinates, which are specified with a WINDOW statement. The programmer may specify the physical size of the screen to be used, arrange to CLIP the picture, SET the color and line style, and use the ASK statement to find out about the current status of these quantities. The GRAPHIC INPUT and GRAPHIC PRINT statements provide text input and output. Polygon fill can be accomplished by:

```
MAT FILL POLYGON
```

Complicated pictures may be built from simple ones with PICs, which are like subprograms. They are invoked with the PLOT statement (rather than with the CALL statement). As they are plotted, transformations of various types may be made. These include SHIFT, SCALE, ROTATE, and SHEAR, and combinations thereof.

Listing 2 is a complete program for drawing a picture of a town.

Real Time

Most BASIC users would be surprised to learn that BASIC is one of the important languages for real-time applications, such as industrial-process control. The reason is that it is simple and can be provided easily on the small machines used in such applications. Standard BASIC will include optional features, such as parallel sections and definitions of device interfaces, to permit this use. This work grew out of earlier work sponsored by the IEEE in developing a standard for CAMAC (Computer Automated Measurement and Control) BASIC.

A real-time program consists of parallel sections, each of which is an independent program unit with respect to line numbers and identifiers. Each parallel section can receive input from and send output to any device specified and can exchange messages with other parallel sections. A section can become dor-

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```
1 JAN 1982          SUPERVYZ Function Selection Menu             12:34:55 PM
  1)  Set Current Date and Time            6)  Accounting [A/R A/P G/L P/R O/E
  2)  Select Default Disk and User         7)  Data Base Inquiry and Reporting
  3)  Add or Change SUPERVYZ Menus         8)  Word Processing
  4)  Extended Volume Table of Content     9)  Data Entry and Verification
  5)  File and Disk Support Functions     10)  Forecasting and Planning

      Please enter the number of the desired function [0 if none, ? for help] [    ]

                 This is the operator/machine conversational text area.

             The above menus are easily adaptable to your specific requirements.

Default Drive = A         Volume Table of Contents [VTDC]          Default User = 1
 A  ACCOUNTS MNU        A  DATABASE MNU             A  DATANTRY MNU
 A  SUPERVYZ MNU        A  FORECAST MNU             A  WORDPROC MNU

                                                    Push ↓ arrow for more
```

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How Standards Are Written

One characteristic of standards work is that major points are usually settled easily, while seemingly minor points may take years to resolve. A classic example is the "option base controversy" in the X3J2 committee.

Most early versions of BASIC allowed default dimensioning of arrays. That is, in the absence of a DIM statement, the subscripts of an array (list or table) could range up to a value of 10. But BASICs differed in what they allowed for the lower bound. Some specified the lower bound to be 0, while others specified it to be 1. The argument for 0 is that many elementary applications need the subscript 0, and it should be available for those cases. The argument for 1 is that most arrays naturally begin with 1, and it would be a waste of storage to allow 0 when it isn't needed. The committee argued long and hard over this one. Each time we voted, we tied. The OPTION BASE compromise eventually emerged. The rule is this: if OPTION BASE 0 appears in the program, the lower bound for all subscripts is 0; if OPTION BASE 1 appears, the lower bound is 1; if neither appears, then by default the lower bound is 0.

Few members of X3J2 really liked this compromise, but the committee supported it in the interests of getting out the standard for Minimal BASIC. Subsequent efforts to remove this feature failed, for the same reason.

In a radical shift, the committee decided, five years later, to allow users to specify lower bounds for individual arrays in dimension statements. Thus, "DIM YEAR(1970:1980)" would create a list named "YEAR" having 11 elements identified with the numbers 1970, 1971. . .1980. If no lower bound is specified, it is assumed to be 1. Both sides now have their wish, but it took more than five years to achieve it.

Logistics

Meetings of standards committees are held near where the members work, and members take turns hosting meetings. Since 1974, X3J2 has met 30 times. Ten of these meetings have been in the East, nine in the Midwest and South, and eight in the Far West. Because we are developing the standard jointly with ECMA (European Computer Manufacturers Association) TC21, we hold joint meetings yearly, alternating between the United States and Europe. Three of these meetings have been held in Europe.

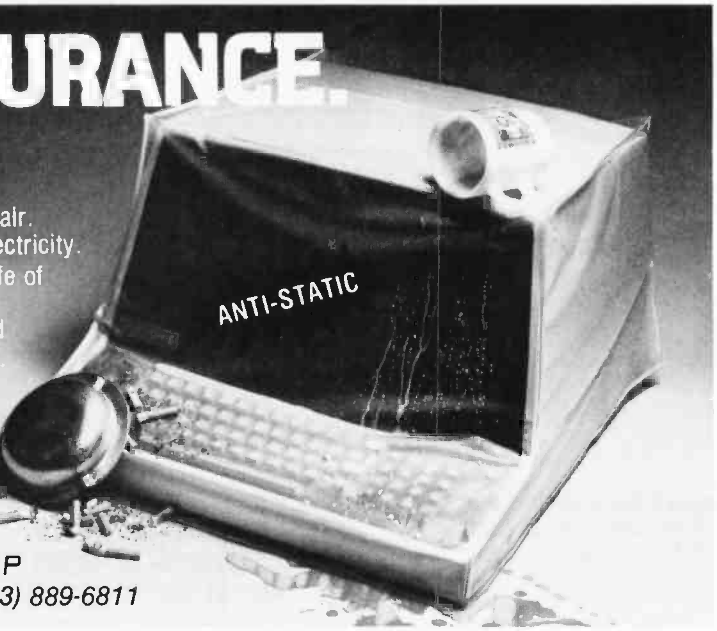
Rotating meeting sites is required. Often we have to choose between alternate sites based on, for example, availability and cost of accommodations. But one factor we always consider very carefully is food. Whatever site we choose must have good restaurants. Thus we're fortunate that 20 percent of the X3J2 membership works in the San Francisco area. In Europe, the ECMA TC21 members work in or near London, Paris, and Venice. I don't know what we would have done had computer companies located themselves in remote areas that offered no culinary delights.

By and large, the membership of X3J2 has been stable. Representatives from large companies sometimes change, and some members change employers. But, for the most part, the members have known each other and worked together for years. This leads to occasional amusing incidents.

In the early days of the committee, before individualized T-shirts became the fad, one member stood up to speak but instead doffed his shirt to reveal his custom T-shirt that had the words "BASIC Standard" on the front and "Strings Subco" on the back. We now take our special T-shirts for granted, but that one brought down the house.

Another member was amused to discover a brand of toilet paper called "Basic"; he presented this as an exhibit to illustrate the then-current status of the standard.

More recently, a member of long standing appeared at a meeting carrying a large plastic goose. When the discussion deteriorated (who can be brilliant for six hours a day all week long?), the goose would appear on the table.



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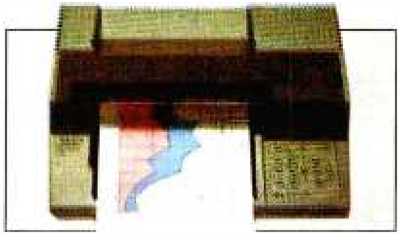

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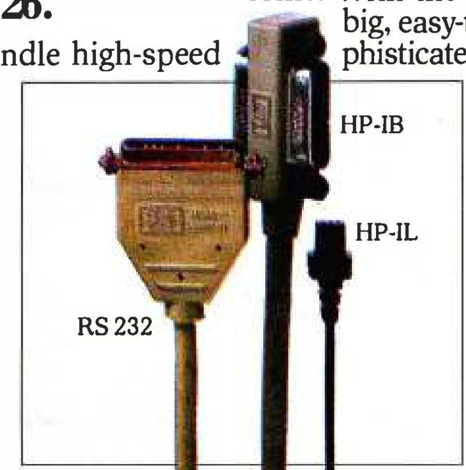

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mant upon reaching a WAIT statement and be awakened when some specified event or condition has occurred. Within a parallel section, all the usual BASIC statements may be used, including subprograms. Of course, there must be a supervisor program behind the scenes that attends to all message passing and scheduling.

As with BASIC in general, an example program that illustrates all of the features of real-time BASIC would be prohibitively long. Just a hint can be gotten from this simple example:

```
320  PARACT RIG1
330     WAIT TIME 17*60*60
340     PRINT "Time to go home."
350  END PARACT
```

This parallel section will "hang" until 61,200 seconds have passed since midnight; it will then "wake up," print the message, and then loop back to the WAIT statement until 5 p.m. the next day.

Fixed Decimal

An optional fixed-decimal module allows programmers to specify that all numeric variables and expressions be fixed decimal. Of use to data-processing programs, it can be invoked by an option statement. For instance:

```
OPTION ARITHMETIC FIXED*8.2
```

specifies that fixed-decimal arithmetic is to be used and that all variables (except those declared otherwise) must permit eight digits before the decimal point and two digits after.

Individual variables may be declared to have precisions other than those prescribed in the OPTION ARITHMETIC statement by using the DECLARE statement. For instance:

```
DECLARE NUMERIC
   national_debt*15.2
```

would allow values up to a penny less than 1 quadrillion dollars.

Editing

Although legally not part of the standard, an optional module will suggest forms to be used for the editing operations often associated with BASIC programs. These include LIST, EXTRACT, DELETE, and RENUMBER.

Summary

For several years now, BASIC has been the de facto standard-programming language for small computers (and in Europe, for business computers as well). Finally, the de facto standard is about to become *standardized*. Far from holding back innovation, the proposed draft standard will be a major force in keeping software up to pace with hardware advances in the eighties.■

References

1. *American National Standard for the Programming Language Minimal BASIC*, X3.60-1978. ANSI, New York, 1978.
2. Kurtz, Thomas E., "Basic," from *History of Programming Languages*. Academic Press, 1981, pp. 515-549.

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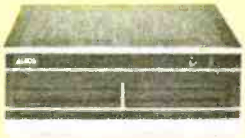

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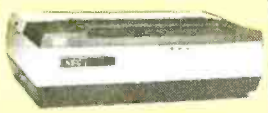

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Software Review

App-L-ISP

Jeff Bonar and Steve Levitan
Computer and Information Sciences Department
University of Massachusetts
Amherst, MA 01003

In a previous article (see "Three Microcomputer LISPs," BYTE, September 1981, page 388), we discussed three implementations of LISP developed for Z80 microcomputers running under the CP/M operating system. Here, we discuss App-L-ISP, a version of LISP developed for the Apple II. The Apple is based on MOS Technology's 6502 microprocessor, which has a smaller instruction set than the Z80. The Apple is far more popular in educational settings than CP/M-based Z80 machines. We believe that LISP can be used successfully in many of these educational settings.

Within this article, we wish to address these questions: What compromises, if any, were made to fit App-L-ISP "onto" the 6502 microprocessor? How well is App-L-ISP integrated into the Apple environment? Is App-L-ISP suitable for the novice?

This article follows the format of our earlier article.

At a Glance

Name
App-L-ISP, version 1.7

Type
LISP programming language

Manufacturer
Datasoft Inc.
19519 Business Center Dr.
Northridge, CA 91324

Price
$124.95

Format
5¼-inch floppy disk

Language
6502 machine language

Computer
Apple II with at least 48K bytes of memory; at least one disk drive

Documentation
68 pages in 3-ring binder, includes a copy of LISP by Winston and Horn

Audience
Educators, college students, language enthusiasts

Data Types in App-L-ISP

App-L-ISP supports a very limited set of data types. It provides atoms, lists, and 16-bit integers. Strings may be simulated using the PACK and UNPACK functions. These functions allow a string to be represented as a list of single-character atoms. For example:

```
(PACK '(A B C D))==> ABCD
(UNPACK 'WXYZ)==> (W X Y Z)
```

The double quote (") is used to delimit atom names that contain characters that might otherwise be misinterpreted. For example:

```
(UNPACK '(WXYZ))==> an error,
  UNPACK expects an atom
(UNPACK '"(WXYZ")==> (" ( W X Y Z ")
```

The last example yields a list of seven single-character atoms, the second of which is the open-parenthesis character.

App-L-ISP has an ASSOC function for manipulating association-lists (often called a-lists). An association-list has the following structure:

```
( (key-1    value-1)
  (key-2    value-2)
  •
  •
  •
  (key-n    value-n) )
```

The call (ASSOC key-i a-list) will return the value-i associated with key-i. For example, given the following:

```
(SETQ FRUIT '((APPLE    RED)
              (BANANA   YELLOW)
              (MANGO    ORANGE)
              (PLUM     PURPLE) ))
```

we have:

```
(ASSOC 'MANGO FRUIT)==> (MANGO
  ORANGE)
```

Traditionally, LISP property lists use association-lists. App-L-ISP does not have a property list associated with each atom. Instead, to use a property list, you must bind an association-list as the atom's value.

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Functions and Arguments

In App-L-ISP, atoms have two values: one used to hold a function or special form, and the other used to hold a normal value. The SET and SETQ functions bind an atom's normal value while DEFINE and DEFINEQ bind the functional or special form value. (The . . . Q form automatically quotes its atomic argument.) The function GETD retrieves a functional value, which is itself an S-expression representing a function or special form.

Anything printed immediately after a Control-D will be treated as an operating-system command.

App-L-ISP allows users to create LAMBDA (call-by-value), NLAMBDA (call-by-name), and MACRO forms. LAMBDA forms evaluate each actual argument and bind the results to corresponding formal arguments. LAMBDA forms cannot have no-spread parameters; each actual argument is bound to a single formal argument. NLAMBDA forms, on the other hand, do not evaluate their arguments. Instead, they bind the actual argument list to a single formal argument. Consider the form FIRST-REST, for example:

```
(DEFINEQ FIRST-REST
  (NLAMBDA (ARGS)
    (LIST (LIST 'ONE
      (CAR ARGS))
    (LIST 'TWO
      (CDR ARGS)) )))
```

Running this form, we have:

```
(FIRST-REST HELP I AM STUCK IN THIS
    MACHINE) ==>
  ((ONE HELP) (TWO (I AM STUCK IN THIS
    MACHINE)))
```

Notice that nothing after the form name is evaluated. Also, all the actual arguments of the form are passed into the formal argument ARGS. MACRO special forms are also available in App-L-ISP. As explained in the earlier article, MACROs allow manipulation of the complete list expression that invokes the MACRO.

Control Structures

Sequential evaluation in App-L-ISP is specified with the PROGN or PROG forms. PROGN sequentially evaluates its subexpressions, returning the results of the last subexpression evaluation. For example:

```
(PROGN (SETQ Z (+ 3 4)) (PRINT (CAR '(A B)))
(* Z 5))
```

binds 7 to Z, prints A, and returns 35.

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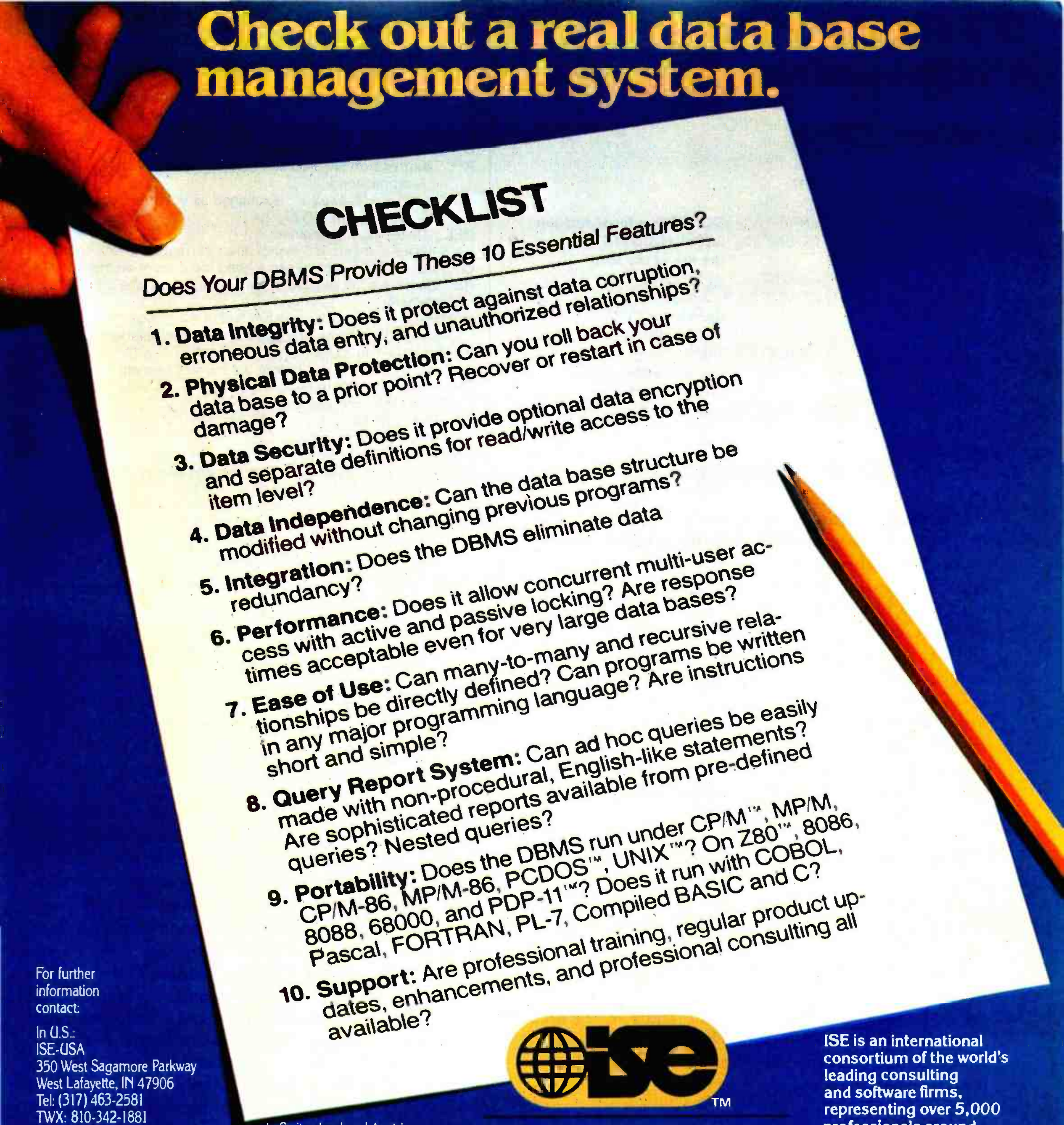

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Listing 1: *COUNT-DOWN illustrates the use of the GO and RETURN forms to decrement the local variable COUNT and then end the evaluation of the PROG.*

```
(DEFINEQ COUNT-DOWN
    (LAMBDA ()
        (PROG (COUNT)              COUNT is a local variable
            (SETQ COUNT 10)        initialize COUNT
            LOOP                   the top of the loop
            (PRINT COUNT)
            (SETQ COUNT (SUB COUNT 1))
                                   decrement COUNT
            (COND ((> 0 COUNT) (RETURN 'BLAST-OFF))
                  (T (GO LOOP)))
                                   test and either exit or
                                    branch back
                                        )))
```

A	Advance to next element of the list you are editing.
D	Down to the first subelement of the current element. The current element must be a list.
B	Back up to previous element.
R <S-expression>	Replace current element with <S-expression>.
X <S-exp1> <S-exp2>	Exchange all occurrences of <S-exp1> with <S-exp2>.
DEL	Delete current element.
I <S-expr>	Insert <S-expr> after current element.
LI	Add a set of parentheses around the current element.
RE	Remove a set of parentheses from around the current element.
<	Group items into a list. After typing "<", type "A" until the last element to be grouped is the current element. Then type ">" to close the list.
PRE <S-expr>	Insert before the current element.
PP	Pretty print entire list being edited.
T	Go to top of list, the first element.
EX	Exit the editor.
C	Display the disk catalog.
E <S-expr>	Edit list specified by <S-expr>.
S <S-exp1> <S-exp2>	Save the expressions in list <S-exp1> on file <S-exp2>.
L <S-expr>	Load expressions from the file <S-expr>.
H	Help. Display the list of edit commands.

Table 1: *The Editor commands available in App-L-ISP.*

PROG also evaluates its subexpressions sequentially, but has a number of other features used to construct loops. The subexpressions of a PROG can be either regular expressions to evaluate, an atom that is used as a label, a GO form, or a RETURN form. Regular expressions are evaluated sequentially, as in the PROGN. A GO form takes a single atom as an argument and causes a branch to the corresponding label. A RETURN form takes a single expression as an argument and causes the PROG to return with the results of evaluating the argument. PROGs also allow you to declare variables local to the PROG body. These local variables are initialized to NIL upon entry to the PROG and restored to their previous values when the PROG returns. To see how this works, refer to the function COUNT-DOWN in listing 1. (Although App-L-ISP does not have a comment convention, we have added annotations in italics.)

App-L-ISP also has the COND, AND, and OR forms. COND is nonstandard in an inconvenient way. It will return NIL if no tests are successful. This makes debugging more difficult than if the COND complained when no test was satisfied. The only predicates in App-L-ISP are > (greater than), EQ (equal to), and # (is the argument a number?). Although this is all you really need to determine the expressions to evaluate, such a limited set is an inconvenience.

User Environment

One of the advantages that the writers of App-L-ISP have, as opposed to the writers of Z80 LISP, is the standard Apple hardware. Unlike Z80 systems, where "CP/M compatibility" is only an ideal at best, an Apple is an Apple. Unfortunately, the editor provided with App-L-ISP does not take advantage of any special features of the Apple.

The editor provided, however, is the best we have seen for a microcomputer LISP. It is a "structure" editor, which means it provides commands that deal explicitly with the list structure of programs and data. Instead of dealing with characters, the commands operate directly on S-expressions. For a list of the editor commands, see table 1.

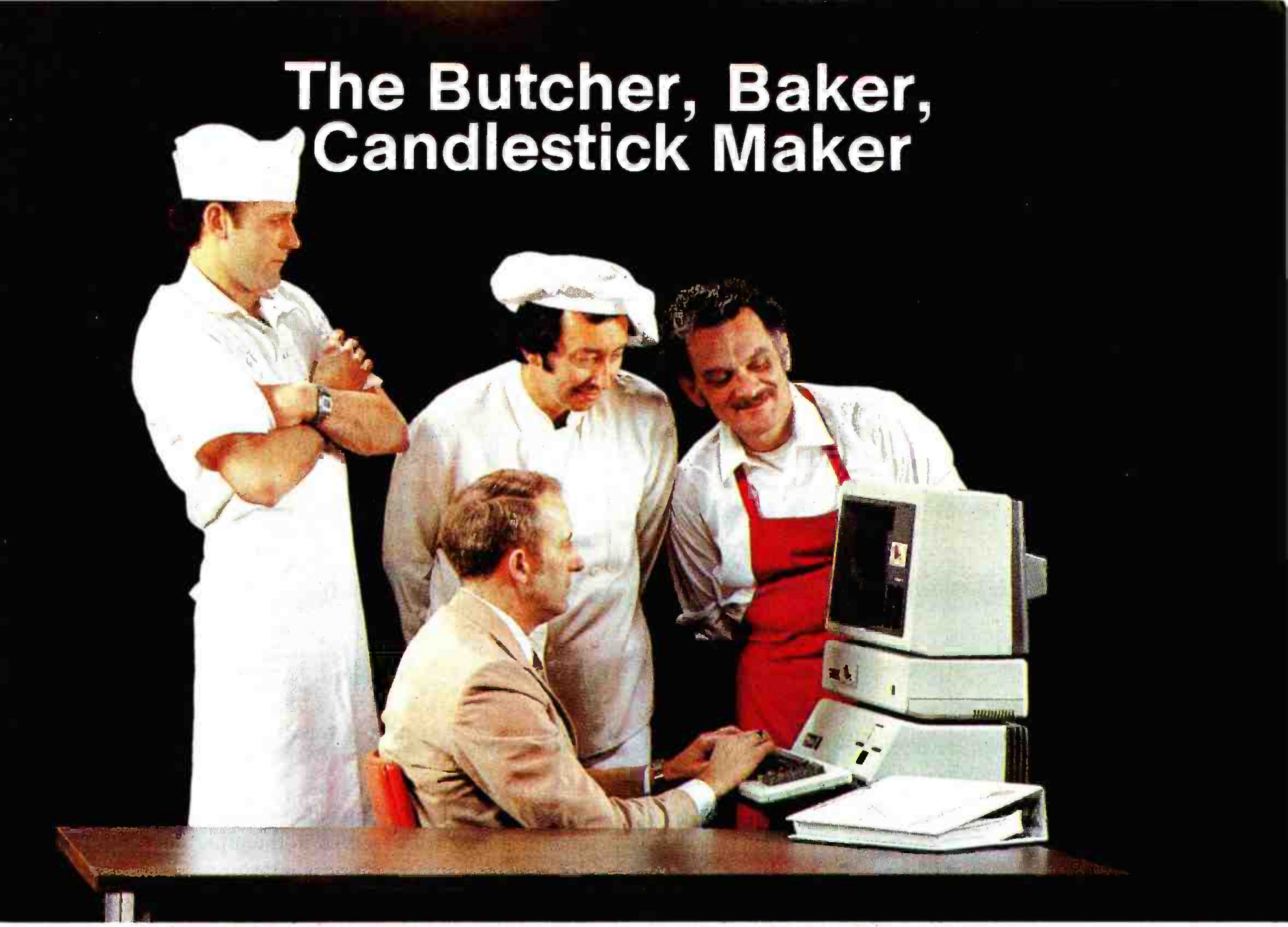
The beauty of a structure editor is that you can "cut and paste" pieces of lists (or functions) without destroying the rest of the list. This kind of editor is tricky to use at first, but after a short while becomes well worth the effort.

We had several problems using the editor. The Help function only returns a list of the command names, with no explanation. The pretty print function does not generate end-of-line sequences at the right edge of the screen; instead, it counts on the Apple hardware to "wrap" to the next line. This is annoying to read on the screen and impossible to use with a printer.

The most serious problem we had was that the editor redefines global variables. For example, our atom "LC" in the timing tests was clobbered by the editor. This problem took several frustrating hours to locate. Normally, this problem is avoided by using lambda-bound variables or PROG local variables. Even when global variables are necessary, they should be given distinguishable names. For example, many LISP systems put an asterisk (*) as the first character of any global variables that the system will modify.

Error Handling

Two types of errors occur in App-L-ISP: "fatal errors" and "error traps." Fatal errors are SYS ERR, MEM FULL, and FORMAL ARG ERROR. These all cause a graceful return to the supervisor. You should then save any unsaved functions and restart App-L-ISP. The fatal errors are caught in such a way that system functions—in particular, SAVE—are still executable.



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The error traps are EVAL ERR, LIST ERR, ATOMIC ERR, SUBR ERR, and NO LABEL ERR. These all invoke the error handler. The handler prints the error name, the current value in the evaluator, and the offending expression. It then allows you to take one of three actions. You can simply restart the supervisor, using the LISP function RESET (*not* the Reset button). Also, you can tell the evaluator what value to return from the error expression, using the RETURN function. The system then continues execution from that point, using the new value. You can also ask for a history of execution with the function BAKTRACE, which prints the stack of functions that have been invoked on the way to the error. This is the cleanest error-handling system for the microcomputer LISPs we have seen.

In addition to calling the error handler on an error trap, user functions can invoke the error handler by calling the function BREAK. You can also stop execution of a function and invoke the error handler from the keyboard by typing Control-B.

The editor and error handler in App-L-ISP together provide a reasonable environment for developing and debugging programs. This is one of the main advantages to using a LISP system in the first place.

User Interaction

User interaction in "immediate mode" suffers from the same problems we observed in the other microcomputer LISPs. The same prompt character, "$", is used to prompt for the first line of an expression and all subsequent lines. This makes it easier to mismatch parentheses.

Another problem is that the normal print function makes no attempt to format its output. Atom names can get split between two lines, making the results difficult to read.

Saving and Restoring Programs

The form (SAVE <S-exp1><S-exp2>) saves functions to the disk. The value of <S-exp1> is taken as a list of names of functions to be saved on the disk. The value of <S-exp2> is taken as the name of the file to use. Only the functions named in the list of <S-exp1> are saved. If the file already exists, it is then overwritten.

Functions are loaded from the disk with the form (LOAD <S-exper>), where the value of <S-exper> is taken as the <file-name>. Whenever this function is run, an atom named %<file-name> is generated. The system then binds a list of all the function names loaded to this atom. This list is then available to be used in subsequent SAVEs.

No provision is made for internal image or binary disk files. The Apple disk operating system (DOS) treats the LISP files as text files.

Program Input/Output

The function (IN= <S-exper>) is available to redirect the data source for the input functions to be the file whose name is the value of <S-exper>. READ will read

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any single valid S-expression and return it as the value of the READ. READA will read a single atom or the single characters open-parenthesis and close-parenthesis. READC will read a single character; it does not wait for a carriage return.

Similarly, the function (OUT= <S-exper>) controls the destination of the functions PRINT, PRIN1, and PRIN2. PRINT outputs one S-expression followed by a carriage return. PRIN1 outputs an S-expression, removing double quotes from atom names. It does not print a carriage return. PRIN2 is like PRINT, but does not print a carriage return.

The forms (OPEN <file-name>) and (CLOSE <file-name>) create input/output (I/O) buffers in memory for disk transfers and clear those buffers, respectively. These are necessary to allow for file I/O. Although we tried several different schemes, we could not get file I/O to work.

The forms (IN# <N>) and (OUT# <N>) also redirect I/O. These specify a slot number, <N>, on the Apple interface bus. OUT# <N> causes data to be sent both to the screen and to the device in slot N. IN# 0 and OUT# 0 reset input and output to normal operation, respectively. If no device is present in the slot specified (except for 0), the system will hang.

Space Management

The NEW and MEM functions allow an App-L-ISP user to control space management. NEW clears all but the predefined forms from memory. MEM explicitly invokes garbage collection and returns the number of free bytes in memory.

It is not clear how App-L-ISP actually manages space. Normally, we would not have complained about this lack of information, as the typical LISP programmer need not be concerned how space is managed. The App-L-ISP manual devotes three appendixes to this subject, however, and none of them is very clear.

Interaction with the Apple

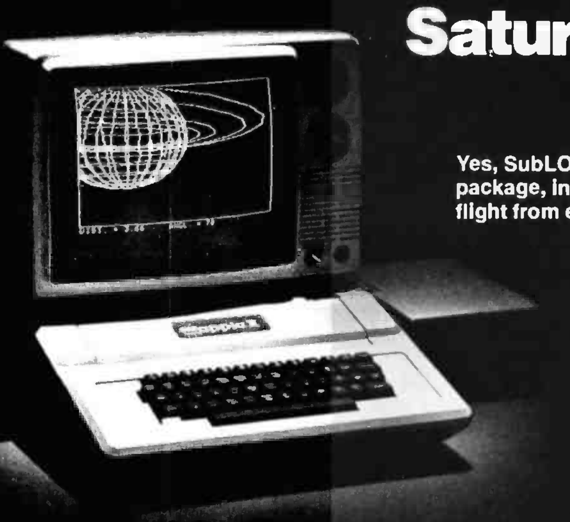
App-L-ISP provides a number of features for interacting with the Apple and Apple DOS. Unfortunately, many of these features are not well explained. For example, App-L-ISP provides PEEK and POKE functions, but it is not at all clear which memory locations are useful or available to the user. Similarly, it has a CALL function that will execute machine code at an arbitrary address, but there are no instructions about where you could put your own code or what system code might be worth calling.

As in Apple BASICs, anything printed immediately after a Control-D will be treated as an operating-system command. This capability seems quite useful to us. Some of the more common operating-system commands are also duplicated as functions. For example, (CATALOG) and (PROGN (PRIN1 '"<Control-D>") (PRINT 'CATALOG)) have the same effect.

App-L-ISP also includes functions to use the Apple tone generator and graphics.

Documentation and Library Software

As we have alluded to in several places, the documentation for App-L-ISP is far too sketchy. The software is distributed with a small manual and a textbook (*LISP* by P. H. Winston and B. Horn, Addison-Wesley, 1981). The manual claims only to contain "synoptic descriptions of the commands available in App-L-ISP." Users are expected to use the manual as a supplement to the textbook. To support this, App-L-ISP is distributed with a set of App-L-ISP functions that, it is claimed, emulate a number of the MACLISP functions used by Winston and Horn.



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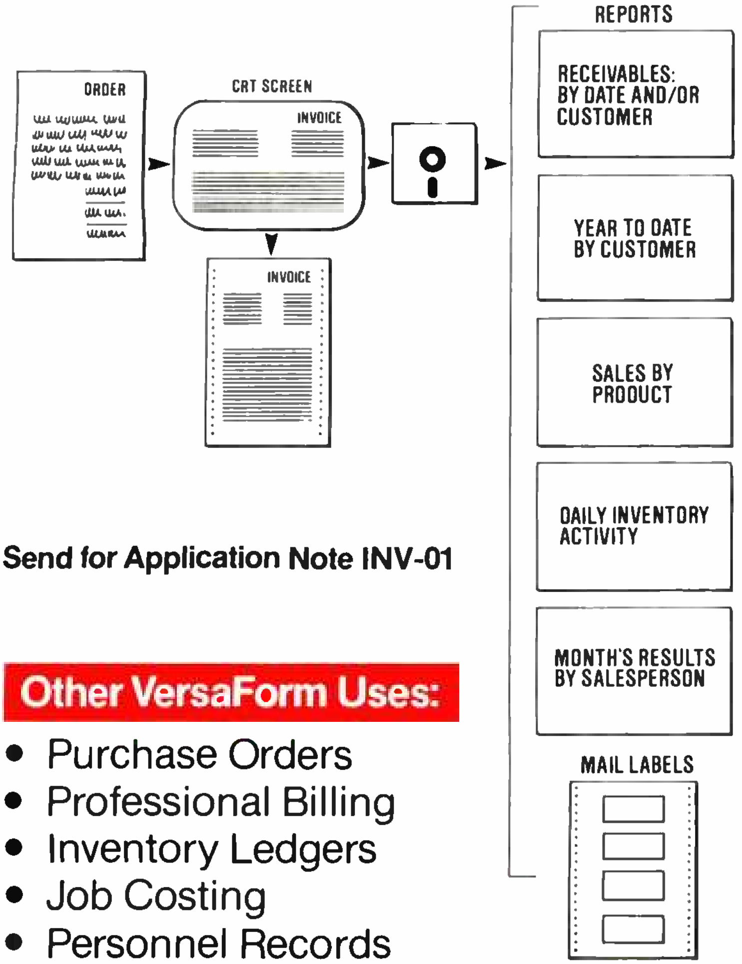

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DC	162
BIGCAR	258
BIGCDR	256
'(HAS-AS-MEMBER-I 'B LONG1)	40
'(HAS-AS-MEMBER-R 'B LONG1)	34
'(REMOVE-ELEMENT-I 'B LONG41)	3
'(REMOVE-ELEMENT-R 'B LONG41)	34

Table 2: *The results of the timing tests applied to App-L-ISP. For the benchmark programs used, see "Three Microcomputer LISPs," BYTE, September 1981, p. 388. This series of tests was conducted as in the previous article (except that the Apple had only 48K bytes of RAM). REMOVE-ELEMENT-I was particularly slow because of a very slow recursive version of APPEND. Trying (TESTER NIL) for more than 10 seconds caused the system to crash.*

LISP is not standard and you need more than a "synoptic definition," particularly since App-L-ISP differs in many ways from the MACLISP dialect of Winston and Horn. In fact, the MACLISP emulation functions are relatively crude and do not always work as described.

Besides being sketchy, the manual is also inaccurate and confusingly organized. For example, the ADD1 (increment 1) predefined function is documented, but not provided. The table of contents is formatted in a confusing way and there is no index.

In addition to the MACLISP emulation functions and the editor functions (discussed in another section), several other files of functions are distributed with App-L-ISP. Included is a simple version of Weizenbaum's ELIZA (called DOCTOR here), a tower of Hanoi demonstration of App-L-ISP's graphics capabilities, functions to use the Apple screen for graphics, and functions to pretty print into a text file. None of these packages are adequately documented. An annotated listing of these files would have been quite helpful. Such a listing would help in both documenting the package and giving badly needed examples of App-L-ISP code.

Conclusions

App-L-ISP provides a minimal, but complete, LISP system that runs at an adequate speed. (The timing tests are shown in table 2. These tests are the same as performed in our article on the Z80 LISPs.) App-L-ISP is slower and has fewer features than the Z80 LISPs.

The documentation, and much of the library software, is inadequate. The manual could easily be doubled in size and should be better organized. The library software should be rewritten so that the global variables used will not interfere with user code.

The editor, while not making full use of the Apple, is quite nice. The pretty printer is not satisfactory, working poorly with the Apple screen and not at all with a printer.

App-L-ISP is suitable as an educational tool for teaching recursion, applicative programming, and basic LISP.■

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Recently we introduced new enhancements to make the DS180 printer even more versatile. Dot addressable raster scan graphics produces output of computer generated charts, maps and graphs at a resolution of 75 x 72 dots per inch. Variable horizontal pitch selection allows printing at 10, 12 or 16.5 characters per inch plus double wide printing at 5, 6 or 8.25 characters per inch. The expanded 2K FIFO print buffer handles a full CRT screen dump at up to 9600 baud without delaying the host system. We also offer transparent mode for isolating communications problems, and for APL users, the dual ASCII/APL character set option.

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- 96 ASCII Character Set
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- 132 Column Print Width
- Tractor Feed (Front or Bottom)
- Non Volatile Format Retention
- Top of Form
- Horizontal Tabs
- Vertical Tabs
- Perforation Skip Over
- Auto Line Feed
- 6/8 LPI
- Auto End of Line Carriage Return
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Technical Forum

Find That Disk

R. E. Bruninga, LCDR, USN
USS Blue Ridge LCC-19
FPO San Francisco, CA 96628

I might never have organized, except that I moved aboard a ship with all my microcomputing junk, and limited quarters dictated more efficient use of space. One of the more annoying problems was what to do with my pile of 5¼-inch disks—the constant shuffling in search of a specific disk was a little like playing with a deck of awkward cards. Separating and boxing them according to broad catagories was no help because each disk still had to be partially withdrawn to determine its contents. This generally resulted in a small wrestling match with the box and the assorted unused write-protect tabs and labels that always seem to get in the way. There had to be a better solution.

There is. And it doesn't cost a cent.

Having no use for those labels, and being the reckless sort who doesn't use write-protect tabs, I came up with the following solution: throw the labels away but save one to label the box. Then place the write-protect tabs in different positions on the top edge of each of the ten disks, as shown in figure 1. Don't write anything on the tabs—they are simply markers that correlate to the legend printed on the inside of the box cover. In fact, the order of the disks as you replace them in the box no longer matters: you can always find the correct disk by reaching for the one with the tab located opposite the desired title on the box lid.

Another advantage is not having to keep track of disk jackets: since you only use one or two disks at a time, you can leave them in the box. Using a disk then becomes a simple task of reaching for the right subject box, removing the selected disk, and inserting it in the right drive. After use, just place the disk in the box in any available jacket. It will always be retrievable by sight!

This system has worked successfully for more then six months and frustration is now a thing of the past. I may have lost my dexterity at card shuffling, but as long as I can continue to ignore write-protect tabs, I look forward to years of happy disk finding. ■

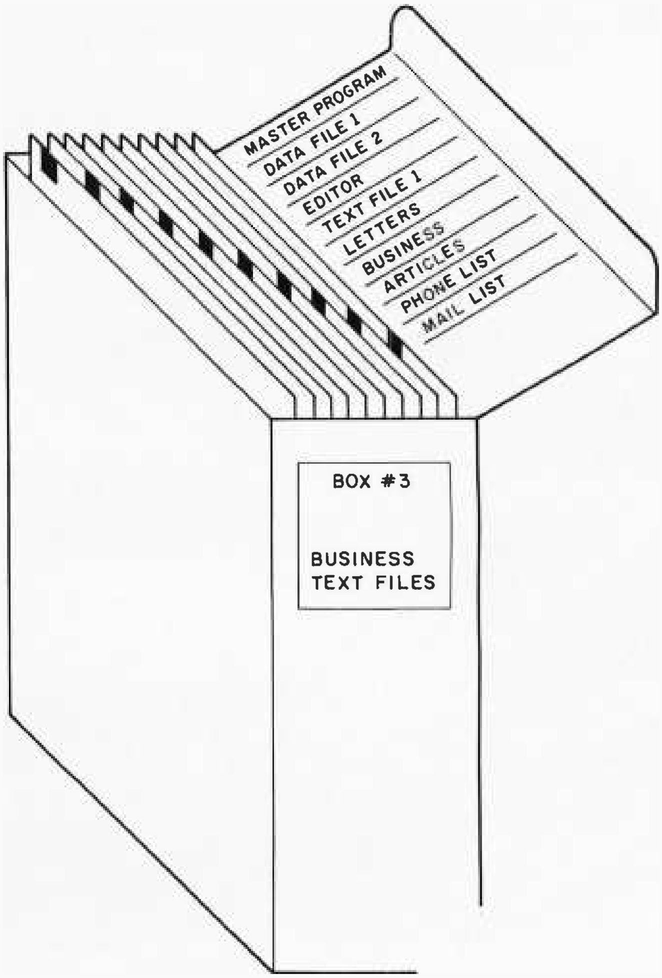
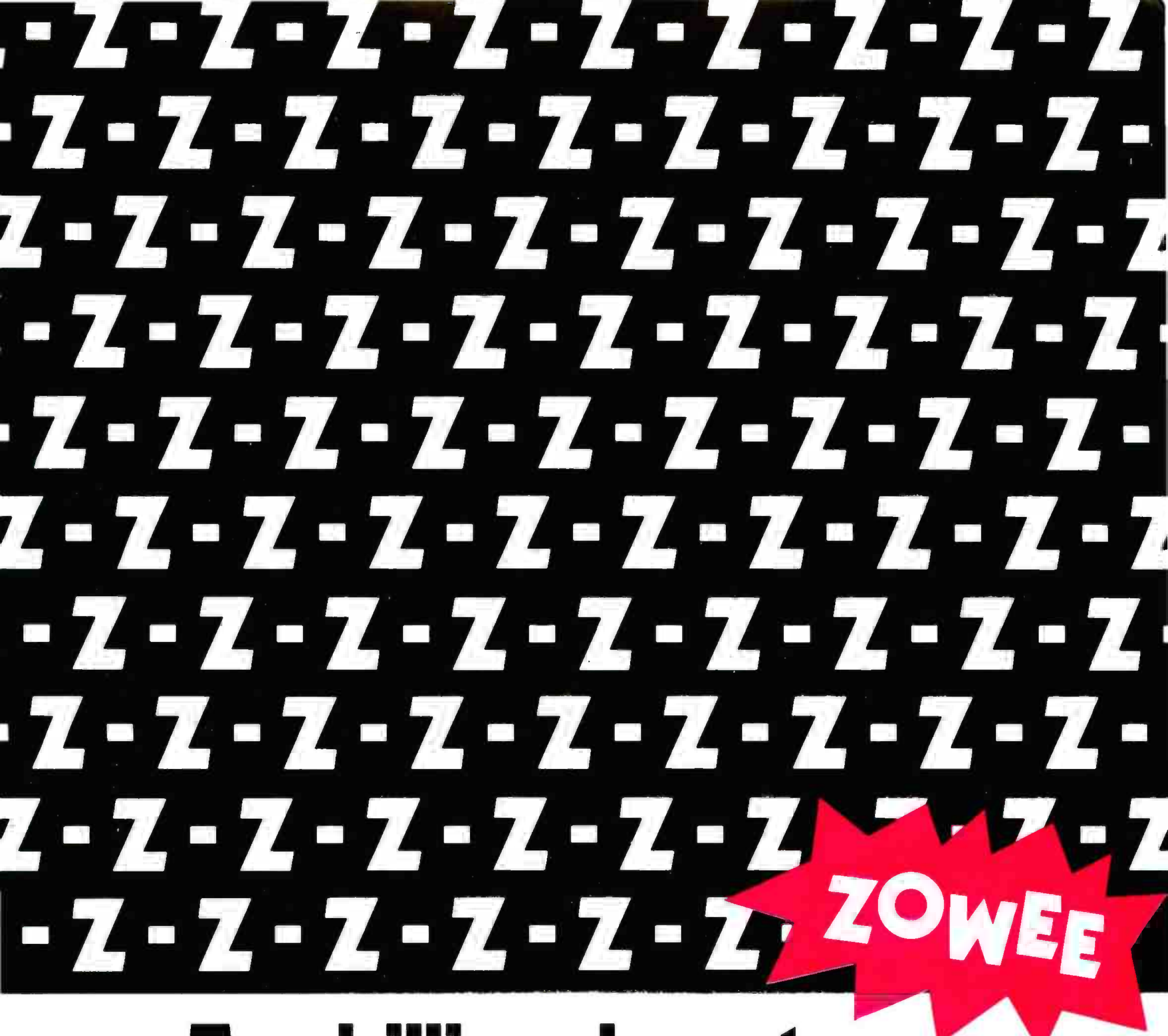


Figure 1: *The write-protect tab on the top of each disk is directly opposite a short description written on the inside of the top cover.*



Two billion characters and still going strong.

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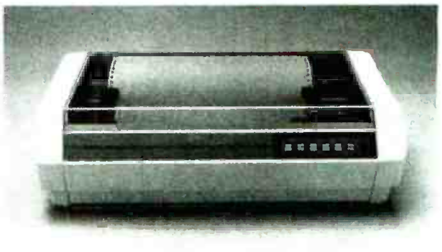

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Software Review

Tawala's Last Redoubt

Hartley G. Lesser
3243 Oakes Drive
Hayward, CA 94542

Broderbund Software has finally released Tawala's Last Redoubt, the fourth and most challenging adventure so far in the Galactic Saga series.

Prior action followed the life of the mighty Emperor Tawala Mundo, whose origin was the small planet of Galactica. As his influence spread with the aid of Julian du Buque, Tawala crowned himself ruler of the 20 planets in the Central Galactic System.

Many years of restlessness followed. The Emperor cashiered du Buque, the one-time commander of Tawala's armed forces, for unstated reasons. Tawala lacked du Buque's skill in planning and logistics and feared du Buque would use his talents against his rule. Thus, Julian du Buque became a hunted man.

Elsewhere dissatisfaction among the merchant class ignited a revolution which du Buque ultimately joined. He led the successful overthrow of Tawala Mundo, and the once-proud and haughty ruler was forced to flee when the rebellion toppled his throne and swept aside his remaining puppets.

A newly opened planet, Farside, became Tawala's refuge. Amid a core of powerful supporters, Tawala constructed a redoubt, a fortification to protect him from those who wanted to destroy him.

The Mission

The fourth adventure begins on Farside. You take the role of a rebel leader named Benthi. The insurgents' camp is veiled by the southern mountains of the inhabited areas of Farside. Benthi—earth-woman, fighter, and strategist—initially leads a small and ill-equipped band of rebels. Your goal is to elicit support from the eight village chieftains, avoid the forays sent by Tawala, and ultimately defeat the Emperor within his redoubt.

No easy task here. The pitfalls are many. Yet with cunning and forethought you can succeed.

Those who have played any of the preceding three Galactic Saga adventures may look forward to the same type of challenge. For those who have no prior experience Tawala's Last Redoubt is the best of the entire series.

At a Glance

Type
Adventure-style game

Manufacturer
Broderbund Software
1938 Fourth St.
San Rafael, CA 94901
415-456-6424

Price
$29.95 (disk)

Author
Douglas Carlston

Format
5¼-inch floppy disk
(13- and 16-sector)

Language
Applesoft BASIC; machine-code subroutines for animation

Computer
Apple II and II Plus; 48K bytes of memory and one disk drive (also available for TRS-80s, cassette and disk)

Documentation
27-page instruction booklet

Audience
Adventure and simulation game players

The Software

I reviewed the package for the Apple II, although versions for both disk- and cassette-based TRS-80s exist. The single disk boots on either 13- or 16-sector systems. The package includes a well-written and interesting rule book that introduces you to the control functions and gives you a history of the revolution on Farside.

Game Features

The first outstanding game feature is its speed. Upon loading, you can indicate how fast you want to play. You can thus accelerate play during the waiting periods or slow the pace when several activities are taking place at once.

The second worthwhile feature is the ability to save up to nine games on the same disk. You can halt and save the

← Circle 4 on inquiry card.

game at any point of play and have nine such partially played games awaiting recall. You are able, for example, to examine different strategies for specific results during any stage of the game.

The instruction booklet contains the 14 input and output routines used in the adventure.

Master Menu

Play is governed by the entry of single-letter or number commands. After you have determined the game's speed, the screen clears to show Benthi's headquarters, designated by a pitched tent and campfire. The action begins here.

A message in the upper left-hand corner of the screen tells you your current location, while the upper right-hand corner displays the passage of time. The master menu is shown in the lower right-hand corner. You have three main options: M)essenger, I)ntelligence, and O)rders.

Military Intelligence

Because you will have very little information when you begin play, the I)ntelligence option perhaps should be examined first. After pressing the letter "I," a submenu that contains the four additional selections M)ap, D)ossier, G)eographical, and S)end Agent appears.

The first selection produces on the screen a map of the area on Farside where the adventure takes place. This consists of Benthi's camp, Tawala's redoubt, and eight villages and their connecting roads. Also shown is your current strength in arms, money, troops, and your current geographic location.

The second selection contains all necessary information on the eight village chiefs. This is important because negotiations with these leaders are the only way you can increase your supply of arms, money, and troops. If this cannot be accomplished, your defeat by Tawala is certain.

The geographical selection deals with the stability of the different inhabited areas, and the fourth selection deals with your two spies. It also opens up communication with your Chief of Intelligence, Paoli. You tell Chief Paoli where you want the spies sent so that the information they gather can be relayed back to you. Paoli is a valuable ally and is best kept close at hand.

The M)essenger function of the master menu brings one of four animated messengers onto the screen. Whoever you call forth runs to the center of the screen, salutes, and asks for orders. At this point you'll tell the messenger to see either one of the village chieftains or one of your own rebels at a certain location. If the former, the messenger may be instructed to ask the chieftain for arms, money, or troops and to determine whether threats should be used to ensure compliance. The messenger then departs; he will tell you when the task is done.

The final master-menu option breaks up the camp to move elsewhere or O)rders your armed personnel either to attack and hold a village or to loot and pillage it. Such actions depend on the movement of Tawala's agents and forces. The latter option would be used primarily against a chieftain who failed to give you the requested aid.

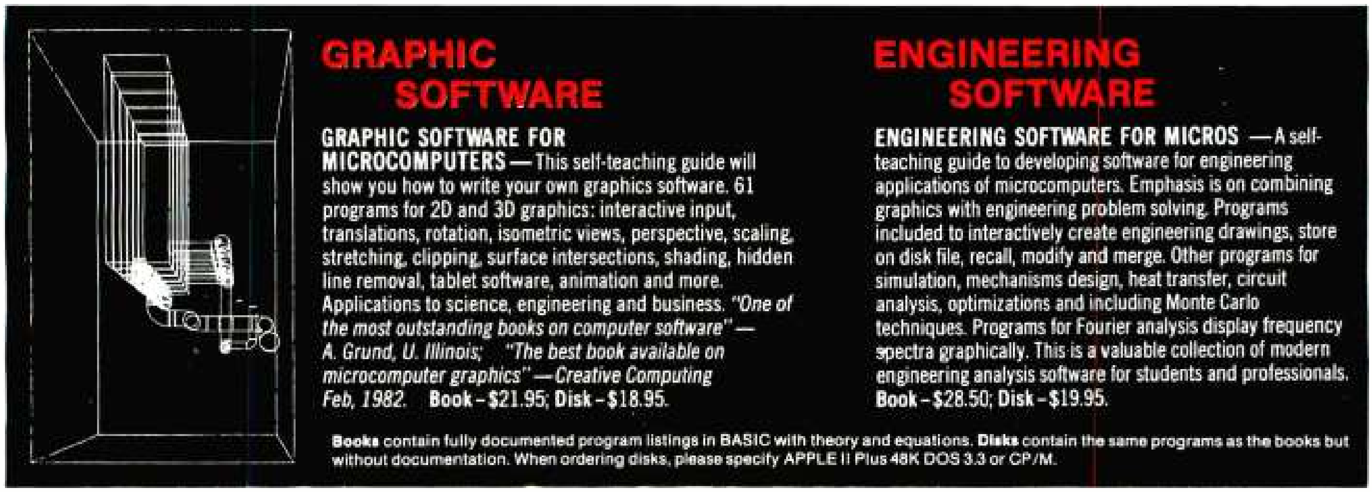
Tactical Considerations

Handling the village chieftains is an exercise in skilled negotiation because they all possess different characteristics. Carefully read their D)ossiers, which Paoli will give you on request, to learn as much as possible about them before you try to bargain for needed equipment or personnel.

Your defeat at the hands of Tawala can come quickly and without warning if you're careless. Suddenly shots will echo about in your location, and bursts of flame will scatter the graphics. This scene will fade, and an evening sky will appear. A man will walk to the center of the screen and salute the heavens, and a touching speech that eulogizes Benthi will scroll before your eyes.

Conclusion

I highly recommend this game for those with a daring and resourceful will; for those who are able to see the forest because of the trees; and for those who can remain undaunted by an occasional defeat.■



Programming Quickies

A Word-Counting Utility for Writers

Steven K. Roberts
5885 Dublin Rd.
Dublin, OH 43017

A microcomputer fully configured for use as a word processor is a valuable and addicting asset to a writer, as anyone who has spent more than a few minutes grappling with a typewriter can well imagine. I doubt that I would be trying to make a living in this volatile word business if my trusty word-processing computer system, BEHEMOTH, weren't here to deal with the brutal realities of somehow getting text from my head to paper.

But writing, it turns out, also involves a variety of data-shuffling tasks that are not directly involved with text editing and formatting. And then there's that fairly trivial but age-old problem of counting the number of words in a manuscript. Yes, you can multiply some average word count per page by the number of pages in the manuscript, but that's inelegant and fails to accommodate stylistic variations that can have significant effects on the length of the average word.

The word count of a manuscript, by the way, is more than an idle bit of trivia born of a love affair with information. Primarily, it is a key specification in article assignments, since the amount of space available to an editor of a publication is predetermined. (Opening the reference book *Writer's Market 1981* at random, I note that *Bird Watcher's Digest* accepts nonfiction articles in the 600 to 3000 word range and fillers of 50 to 225 words.) Second, word count is a part of most book contracts, a fact that is giving me little rest these days (180,000 words, it turns out, is a lot). And finally, observing the amount written each day in some sort of dispassionate and objective fashion can provide useful feedback concerning a writer's output.

If all that text is in the form of disk files, it becomes quite easy to let the computer do the counting, and the Z80 assembly-language program COUNT (see listing 1) accompanying this 781-word [*Before editing*....Ed.] article does just that. Designed to be run under the Cromemco CDOS operating system, it can easily be adapted to CP/M-based systems, while the concept behind it can be applied to other personal computers.

Use of this utility program is straightforward. To count the words in this article, the program is invoked with the command line: COUNT C:WORDCNT.M62.

The text file is called WORDCNT.M62 (the manuscript serial number is 62) and happens to be on floppy disk drive C at the moment. The COUNT program just reads the entire article and accumulates the total number of words, using the space, hyphen, and carriage-return

About the Author

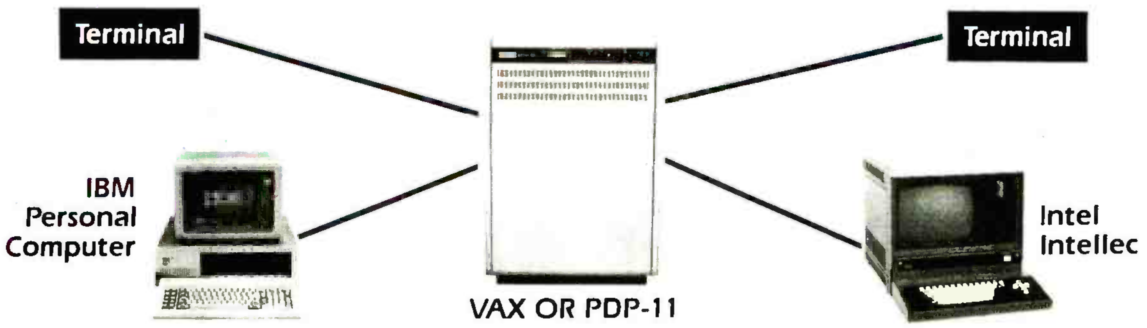
Steven K. Roberts has written numerous microprocessor-related articles and two books. He lives and works in Dublin, Ohio, and offloads as much trivia as possible onto BEHEMOTH, his computer system.

Listing 1: *This Z80 assembly-language program, COUNT, will return the word count of any text file. A word is defined as any group of characters delimited by a space, a hyphen, or a carriage return. When the end-of-file marker is encountered, the total word count is displayed. The subroutine names listed in the comments (FNAME, ZOPN, etc) are Cromemco CDOS system entry points. Their addresses (or the addresses of the equivalent routines on your system) must be set at assembly time.*

```
                            NAME    COUNT
                    ;
                    ;This program wanders through a text file and accumulates the total number
                    ;of words (up to 65,535).  A "word" is any group of one or more characters
                    ;delimited by a space, a hyphen, or a carriage return.
                    ;Execution is invoked with the standard CDOS command format:
                    ;               COUNT file-ref
                    ;The assembled file COUNT.REL must be linked with ASMLIB to provide the
                    ;disk access and binary-decimal routines.  These are characterized as follows:
                    ;
                    ;       FNAME - Sets up extended FCB from an FCB.
                    ;       ZOPN  - Opens an existing file.
                    ;       ZIOER - Prints file error message from ZOPN.
                    ;       ABORT - Prints a message and exits to CDOS.
                    ;       GCHAR - Inhales one character from the file.
                    ;       BINDB - Converts binary number to decimal string.
                    ;
                    ;HISTORY:       Created 10/3/80 (SKR)
                    ;               Edited for MS62 1/1/81 (SKR)
                    ;               Edited for MS55 1/7/81 (SKR)
                    ;
                            EXTRN   FNAME,ZOPN,ZIOER,ABORT,GCHAR,BINDB
                    ;
0000' 3A5D00        START:  LD      A,(5DH)         ;If the first byte of the filename
0003' FE20                  CP      ' '             ;   is blank, print error message
0005' CA6500'               JP      Z,ERROUT
0008' 97                    SUB     A               ;Set up file control block.
0009' 215C00                LD      HL,5CH
000C' 119600'               LD      DE,IXFCB
000F' CD0000#               CALL    FNAME
0012' CD0000#               CALL    ZOPN
0015' CC0000#               CALL    Z,ZIOER
                    ;
0018' 210000                LD      HL,0            ;Initialize word count
001B' 229400'               LD      (COUNT),HL
001E' AF                    XOR     A
001F' 329300'               LD      (LAST),A        ;   (and the LAST status bit)
                    ;
0022' 119600'       LOOP:   LD      DE,IXFCB        ;Get a character from the file
0025' CD0000#               CALL    GCHAR
0028' FE1A                  CP      1AH             ;If it is EOF, quit
002A' 2829                  JR      Z,EOF
002C' FE20                  CP      SPACE           ;If space, hyphen, or CR, we are between words
002E' 280C                  JR      Z,YUP
0030' FE2D                  CP      DASH
0032' 2808                  JR      Z,YUP
0034' FE0D                  CP      CR
0036' 2804                  JR      Z,YUP
0038' 0600                  LD      B,WORD          ;Otherwise, we're in a word
003A' 1802                  JR      TEST            ;Set B=1 and go test
003C' 0601          YUP:    LD      B,INTRVL        ;Set B=0 and test
003E' 3A9300'       TEST:   LD      A,(LAST)        ;Get the last status
0041' B8                    CP      A,B             ;Same?
0042' 28DE                  JR      Z,LOOP          ;If so, go get another character
0044' FE01                  CP      A,INTRVL        ;(Only count word -> interval transitions,
0046' 2007                  JR      NZ,SAVE         ;  not the opposite.)
0048' 2A9400'               LD      HL,(COUNT)      ;Else, increment the word count
004B' 23                    INC     HL
004C' 229400'               LD      (COUNT),HL
004F' 78            SAVE:   LD      A,B             ;  then save the new status
0050' 329300'               LD      (LAST),A
0053' 18CD                  JR      LOOP            ;    and loop.
                    ;
0055' 218C00'       EOF:    LD      HL,STRING       ;Translate binary count into decimal string
0058' ED4B9400'             LD      BC,(COUNT)
005C' CD0000#               CALL    BINDB
005F' 217F00'               LD      HL,EOFMSG       ;Print it
0062' CD0000#               CALL    ABORT
                    ;
0065' 216B00'       ERROUT: LD      HL,ERRMSG       ;Print an error message
0068' CD6300#               CALL    ABORT
                    ;
006B' 53706563      ERRMSG: DEFB    'Specification Error',13
      69666963
```

Listing 1 continued on page 240

8086/8087/8088 CROSS SOFTWARE TOOLS



OPTIMAL DEVELOPMENT ENVIRONMENT

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a) all host commands are available.
b) files can be moved to/from a mounted file system located at the workstation, and
c) 8086/8087/8088 files can be executed at the workstation.

For example, assume that your editor is written in portable C, is running on the host system, and is giving poor response due to host system loading. To gain real-time response, simply cross-compile it on the host, move it to your workstation, and execute it there. You can move programs, including the C compiler itself, to your workstation as desired. Note that the workstation does not require massive amounts of file storage to provide a host system environment.

The workstation can be decoupled from the host for stand-alone operation.

Workstations supported: IBM Personal Computer and Intel Intellec system. Coming soon: DEC Personal Computer.

2 PASCAL AND/OR C CROSS-COMPILERS

For Pascal, all facilities of the ISO definition are supported. For C, all facilities of the complete language, including floating point for the 8087 and 32-bit pointers, are supported. Optionally, memory can be allocated for optimal use of the 8088. Output is symbolic assembly language. Optionally, the output contains symbolic debug information.

3 CROSS ASSEMBLER/LINKER LIBRARIAN/LOADER

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Host System for 2 and 3:
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Circle 11 on inquiry card.

Listing 1 continued:

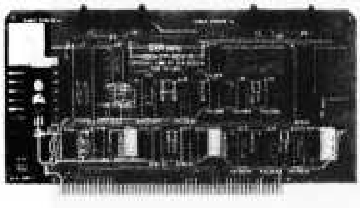
```
        6174696F
        6E204572
        726F720D
007F'   576F7264      0075 EOFMSG: DEFB    'Word count = '
        20636F75
        6E74203D
        20
008C'   30303030      0076 STRING: DEFB    '000000',13
        30300D
                      0077 ;
0093'   00            0078 LAST:   DEFB    0               ;Word/interval flag
0094'   0000          0079 COUNT:  DEFW    0               ;Binary word count
                      0080 ;
0096'   00            0081 IXFCB:  DEFB    0
0097'   (0022)        0082         DEFS    34
00B9'   BE00'         0083         DEFW    IBUFF,0
        0000
00BD'   04            0084         DEFB    4
00BE'   (0200)        0085 IBUFF:  DEFS    80H*4           ;Disk buffer
                      0086 ;
        (0020)        0087 SPACE:  EQU     20H
        (002D)        0088 DASH:   EQU     2DH
        (000D)        0089 CR:     EQU     0DH
        (0000)        0090 WORD:   EQU     0
        (0001)        0091 INTRVL: EQU     1
                      0092 ;
02BE'   (0000')       0093         END     START

Errors                0

Program Length  02BE (702)
```

characters as delimiters. When it encounters the end-of-file mark (hexadecimal character 1A), it stops and displays the word count on the console.

This final value, it should be noted, includes any output-formatting directives associated with the word-processor that are embedded in the text, introducing a slight error in excess of the actual number of words. The word count of this article includes twenty-three nonprinting "words" (formatter commands). If you are paid by the word, it might be worthwhile to add a test for whatever command prefix character your formatter requires and suppress the normal toggling of the LAST flag (see listing 1) when one is found—but that may be more trouble than it's worth.

For convenience, I have built COUNT into a batch file that takes care of formatting the text on my Diablo printer. Thus, each time an article or chapter is printed, its word count is displayed and can be noted on the title page, used for gambling purposes, or ignored entirely. In a current textbook project (*Industrial Design with Microcomputers*, to be published by Prentice-Hall), I am adding weekly segments to a graph fondly dubbed the "PFD curve": cumulative word count is plotted against time with a straight reference line drawn from the start of the project to the deadline. Naturally, the actual curve is roughly exponential, with a nice lazy slope at the beginning, a knee at the onset of stress, and a nearly asymptotic rise in the last few weeks as the approaching deadline triggers panic. Oh yes, "PFD" stands for "Procrastination Followed by Despair."

The word-count program allows informed, rather than naive, dismay at the amount of work left to be done in an ever-dwindling amount of time. Ain't technology wonderful?■



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The Input/Output Primer

Part 5: Character Codes

Character codes turn computer data into messages that people can understand.

Steve Leibson
Cadnetics Corporation
5797 Central Ave.
Boulder, CO 80301

Last month, we looked at two interfaces: the BCD (binary-coded decimal) and the RS-232C serial. Our examination of these interfaces and our earlier look at the parallel and IEEE-488 interfaces showed some of the strides made in achieving hardware compatibility in data communications.

But hardware is only half the battle. All the people of the world share the same hardware for spoken communications: the lips, teeth, tongue, larynx, and the rest of the complex vocal tract for transmitting, and the ears for receiving. Spoken communication, however, is possible only when two people know the same language—the same way of encoding information.

Just as speech would be impossible without common languages, communication between computers would be impossible without agreement on character codes. For this month, we will put aside considerations of equipment compatibility and concentrate on the codes that enable machines to communicate with one another.

As described earlier in this series, digital computers use a binary language to represent information internally. Since some of the devices to which computers must talk are designed for human use—notably printers and video-display terminals—it is important that a computer communications code be compatible with human communications. Several methods to achieve such compatibility are available. Each method involves a different way of encoding the letters and numerals that form the basis of person-to-person communication.

The advantages of having all computers use the same computer communications code are clear. While the quality of codes varies enormously, almost any universal standard would be better than none. The road to a single standard communications code has not run straight, however, and has yet to reach its destination. A look back down this road will make the status of contemporary communications codes easier to understand.

This article is the fifth in Steve Leibson's six-part series, The Input/Output Primer*. The series describes the problems involved in communications between computers and the outside world, and explains how some of these problems have been solved. The last article will discuss interrupts, buffers, grounds, and signal degradation. "An I/O Glossary," which defines many terms used in these articles, appeared with the series' first installment (February 1982 BYTE, page 122). Table numbers are continued from Part 3.*

The Greek Standard Code

Long before the invention of the computer, people encoded information so they could communicate beyond the range of the human voice. Smoke signals, drumbeats, and flags all served to extend the range of communication.

Perhaps the first character code was that devised for the Greek alphabet in about 300 BC. The 24 letters were placed in a 5 by 5 arrangement, starting with alpha in row 1, column 1, and ending with omega in row 5, column 4. To signal each of the 24 characters, the Greek signalmen set vases atop two walls. The number of vases on one wall indicated the number of the row occupied by a character in the 5 by 5 table; the number of vases on the other wall indicated the number of the column occupied by the character. By setting five vases on the row wall and four vases on the column wall, a signalman could send the character omega.

Although understandable in a vase-intensive culture with an abundance of slave labor, this means of communication had obvious drawbacks. For one thing, it suffered from the age-old problem of working only as far as the eye could see. Greater range required bigger vases. When vases became so big that men could hardly lift them, however, the rate of transmission must have slowed from say, 1 character every 2 minutes to 1 every 15 or 20 minutes. (This is a hardware problem, it's true; forgive the digression.)

Other problems with the Greek system were definitely in the software. The 5 by 5 table left no room for numerals and punctuation. The code derived from the 5 by 5 table also allowed no provision for error checking. Evidently, no one saw the need for anything like a parity vase. Attempts at handshaking were also doomed. You could have used the twenty-fifth character (five vases on each wall) to mean "start sending," for example, but what could you do to say "stop sending"? Smash a vase?

Euclid, who was then living in Alexandria, could probably have straightened out the system in the beginning if someone had turned the matter over to him. The history of telecommunications might have avoided two millennia of needless confusion and grief. Unfortunately, no one bothered asking Euclid, or his consulting fee was too high.

As a result, the 5 by 5 table has plagued communications codes down the centuries. More than a thousand years later, prisoners in medieval dungeons communicated by using a similar 5 by 5 table to encode the 26 letters of the Roman alphabet. To squeeze 26 characters into 25 places, the prisoners used the same coordinates for both I and J. The prisoners sent messages by tapping out pairs of numbers; one tap followed by one tap meant A.

The torments of the 5 by 5 table afflicted everyone from the bottom of society to the top, from prisoner to intellectual. In 1551, the Italian mathematician Gerolamo Cardano proposed using five torches on five towers in much the same way the prisoners had used sounds. By 1803, inventors in both France and Germany had devised optical telegraphs using codes much like Cardano's.

Electrifying Changes

The discovery and harnessing of electricity introduced many new possibilities, but no one seemed to know quite what to do with them. One of the early proposals for a telecommunications code, submitted to a Scottish magazine in 1753 and signed "C. M.," was simple but had profound implications for hardware. C. M. wanted to run 26 parallel wires from town to town, one wire for each letter of the alphabet. A Swiss inventor built a prototype system based on this 26-wire principle. Too bad there was a shortage of wire.

In 1833, Carl Friedrich Gauss used a code like Cardano's to send messages by deflecting a needle five times, right or left.

Samuel Morse and others soon put electromagnets to use in communications. Morse devised his code of dots and dashes by 1835, and demon-

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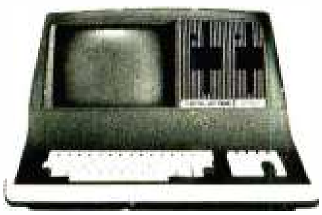

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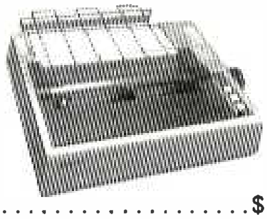

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strated the code repeatedly in 1838. (The best-known demonstration took place in 1844, when Morse transmitted over a wire from Washington to Baltimore the message, "What hath God wrought?") For a time, 5 ceased to be a magic number in communications codes. Morse's code used combinations of from one to six dots and dashes—a dash lasting three times as long as a dot—to represent each of the characters and figures, with pauses indicating the end of one character or word and the beginning of the next. The Morse code soon became the standard in the United States. Europeans found Morse code wanting because it didn't include characters with diacritical marks. To correct this deficiency, the Europeans developed an international version of Morse code in 1851.

Morse and Machine Decoding

Early in the twentieth century, interest developed in replacing human telegraph operators with machines. Morse code was unsuitable for machine decoding because of the problems caused by the varying lengths of the characters.

On the other side of the Atlantic, J. M. E. Baudot developed a code around 1880 that became one of the standards in international telegraph communications. Since Baudot's code used the same number of binary digits to represent each character, it was better suited to machine decoding. Unfortunately, the number of binary digits was only 5 (there's that number again). The 5-bit code could generate only 32 possible combinations, fewer than necessary to represent the 26 characters of the alphabet, the 10 decimal digits, and the punctuation marks.

Baudot used two shift-control characters—the letter shift and the figure shift—to permit the code to represent all the characters thought necessary. The shift codes do not represent printable characters but select one of two character sets, each composed of the 32 characters. Receipt of a letter-shift code causes all following codes to be interpreted as letters of the alphabet; receipt of a figure-shift code causes all the follow-

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ing characters to be interpreted as numerals and punctuation marks. For example, following the letter shift, the sequence 10000 stood for "A"; following the figure shift, the same sequence meant "1."

After designating 2 of the 32 possible codes as shift codes in each character set, Baudot code was left with 30 codes for representing characters in each set. That was still not enough characters for efficient, reliable machine communication. Baudot's code makes all combinations of 5 bits meaningful, which leaves no bit for error checking. The loss of a bit could garble an entire message. All the telegraph companies could do to guard against errors was to retransmit all the figures in a message after the end of the message itself.

Another 5-bit code, the Murray code, came into use around 1900. Murray code differed from Baudot code only in some of the code assignments to characters. Murray code also used shift characters and lacked error checking. As with Baudot code, the proper interpretation of a message depended on characters previously received. Unless the receiving device knew which character set to use—letters or figures—there was a 50 percent chance of incorrect decoding. The main contribution of Murray code was incompatibility with Baudot code—the first input/output incompatibility problems.

Clearly, 5 bits were not enough. Modern communications required a code that could represent all printable characters and still leave room for error checking. The code had to permit decoding without reliance on correct reception of previous transmissions, and also had to permit decoding by machine. Perhaps most important of all, the new code needed to be expandable. Machine communications should not be trapped in still another dead-end system.

The Two New Codes

By the time the need for this new code was felt, the technology capable of supporting more complex codes was available. Many manufacturers were building equipment that could potentially use a new character code. Whenever the need arises for standardization, such standards can come into existence in two ways. A single manufacturer can simply invent a solution, expecting the rest of the industry to follow. This is what IBM did. It created the EBCDIC (Extended Binary Coded Decimal Interchange Code) character code, which is an 8-bit code allowing 256 characters to be represented. Since there aren't that many printable characters, several codes in EBCDIC aren't used.

No other manufacturer chose to follow IBM's lead. (Maybe no one could pronounce the name of the new code.)

ASCII at Last

The other method of obtaining a standard is through compromise in a committee. Other manufacturers met and produced a national standard called ASCII (American Standard Code for Information Interchange). It's pronounced "ask-key."

ASCII is a 7-bit code, formally known as ANSI (American National Standards Institute) standard X3.4-1977. One hundred and twenty-eight characters are represented in ASCII, not all of them printable. Included in the character set are all the letters of the alphabet (both uppercase and lowercase), the 10 numerals, and punctuation marks. Table 4 shows the ASCII characters and their associated codes.

The nonprintable codes are *control codes*, so called because they control the operation of the receiving device. Carriage return and linefeed are control codes familiar to anyone who has used a typewriter. Other control codes include formfeed, bell, and horizontal and vertical tabs. These control codes were clearly set up for printing or display devices, although some manufacturers have pressed the control codes into service for all manner of special functions.

Finally, as in the 5-bit codes, some codes control how a receiving device will interpret subsequent codes. Two shift characters called *shift in* and *shift out* are used to shift between ASCII and character sets other than

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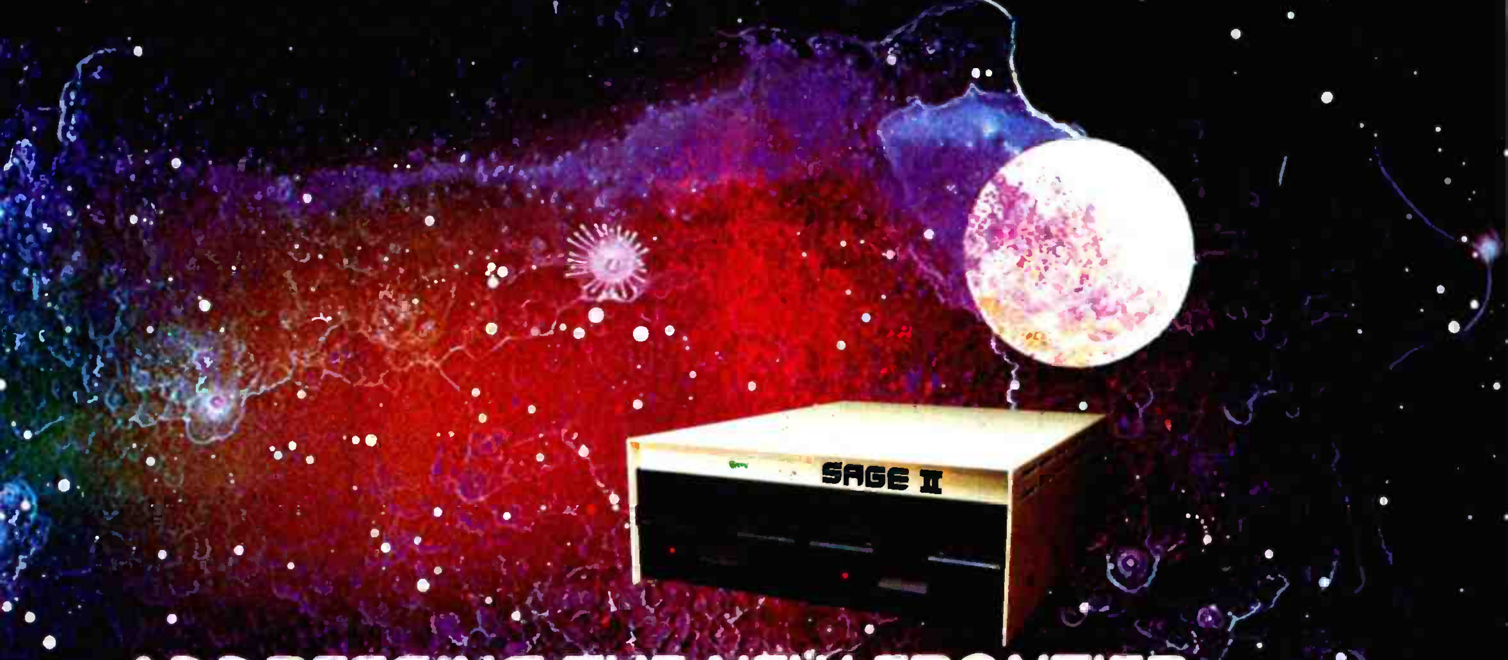

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b_7 b_6 b_5						0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
Bits	b_4	b_3	b_2	b_1	COLUMN ROW	0	1	2	3	4	5	6	7
	0	0	0	0	0	NUL	DLE	SP	0	@	P	`	p
	0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
	0	0	1	0	2	STX	DC2	"	2	B	R	b	r
	0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
	0	1	0	0	4	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

Mnemonic and Meaning[1]		Mnemonic and Meaning[1]	
NUL	Null	DLE	Data Link Escape (CC)
SOH	Start of Heading (CC)	DC1	Device Control 1
STX	Start of Text (CC)	DC2	Device Control 2
ETX	End of Text (CC)	DC3	Device Control 3
EOT	End of Transmission (CC)	DC4	Device Control 4
ENQ	Enquiry (CC)	NAK	Negative Acknowledge (CC)
ACK	Acknowledge (CC)	SYN	Synchronous Idle (CC)
BEL	Bell	ETB	End of Transmission Block (CC)
BS	Backspace (FE)	CAN	Cancel
HT	Horizontal Tabulation (FE)	EM	End of Medium
LF	Linefeed (FE)	SUB	Substitute
VT	Vertical Tabulation (FE)	ESC	Escape
FF	Formfeed (FE)	FS	File Separator (IS)
CR	Carriage Return (FE)	GS	Group Separator (IS)
SO	Shift Out	RS	Record Separator (IS)
SI	Shift In	US	Unit Separator (IS)
		DEL	Delete

Table 4: *The table of ASCII (American Standard Code for Information Interchange) characters. Since ASCII is a 7-bit code, it has 128 characters (2^7). Some of the characters are printable, but others are control characters. The table shows all the control characters but one (DEL) in the first two columns. DEL is the last character in the last column.*

The head of each column gives the most significant 3 bits (in both binary and decimal) of the characters in the column. The left of each row shows the most significant 4 bits of the characters in the row.

To find the ASCII code for "E," for example, locate "E" in the table. The 3 bits at the head of that column (100) are the most significant 3 bits in the code for "E." Then, get the least significant 4 bits from the extreme left of the row that contains "E" (0101). The full code for "E" is 1000101.

those used in English. ANSI standards X3.41-1974 and X3.64-1979 expand the definition of the *escape* control code for even greater flexibility.

Some control codes delimit text, such as *start of text* and *end of text*. These codes are used primarily in block transmissions.

ASCII has been a very successful character code. Thousands of instruments and computer-related products use it for interfacing. Even IBM now offers equipment that understands ASCII.

Almost any hardware interface can handle ASCII transmissions. The exception is the BCD interface, designed to handle 4-bit BCD codes.

Planning the Escape

The developers of ASCII tried to foresee as many different applications as possible. That is why they included the various control codes. They recognized that technological advances could not be well predicted. Therefore, they gave themselves an escape clause.

As was mentioned above, one of the ASCII characters is the *escape* character. It designates that the codes that follow have special meaning.

The intent in creating the *escape sequence* was to extend the range of the character set by allowing selection from a range of available sets. Graphics characters, foreign-language character sets, and special applications sets have been developed. Escape-character sequences allow for a much richer variety of printable symbols than the simple shift in/shift out scheme of the 5-bit codes.

The now common video-display terminal has provided the escape sequence its widest application. The inclusion of microprocessors in terminal design has greatly augmented video-display capabilities. The serial-communications link to these terminals has not changed in years. Only one data channel to the host is available. Ordinarily, any characters received via this channel are displayed on the terminal screen. But the ASCII standard did not foresee capabilities for character and line deletion; display enhancements such as inverse video, underlining, and blinking; and even control of tape drives built into a terminal. The escape sequence allows manufacturers to add these system functions while remaining compatible with ASCII.

Escape to Chaos

Manufacturers of video-display terminals are now using escape sequences to add increased performance to their products. Unfortunately, little standardization of these sequences existed until the X3.64 standard came out in 1979. Without standardization, designers felt free to exercise their creativity.

For example, one major feature now found on most video-display terminals is absolute cursor positioning. The computer can send a command to the terminal that will place the cursor anywhere on the screen. This capability is important for many types of form-filling operations. There are about as many escape sequences to do this task as there are terminal manufacturers. The Digital Equipment Corporation (DEC) has several varieties, depending on the vintage of the terminal. The new DEC terminal, the VT100, is one of the few terminals available today that conforms to the X3.64-1979 standard.

How does an escape sequence such as cursor positioning work? The host computer starts by sending the escape character. This is followed by one or more characters that indicate the type of escape sequence. Two or more characters then follow giving the desired *x* and *y* coordinates for the cursor. Some escape sequences self-terminate. When the receiver has obtained the right number of characters, it exits the escape-sequence mode and returns to normal mode.

Self-terminating escape sequences don't meet ANSI standards. The X3.41 and X3.64 standards are quite explicit about what kinds of characters can appear in escape sequences. All legal escape sequences have proper terminating characters. This allows for variable-length escape sequences.

Characters received in an escape sequence are not interpreted as printing characters but as control information. The escape character has the effect of making all character codes available for control of a device.

Code Conversion

The vast majority of computer equipment available today uses the ASCII character set. Unfortunately, some older equipment does not. Interfacing these older devices may require conversion of ASCII characters to the character codes the peripheral device would like to see. (We assume that the hardware-interfacing requirements have already been met.)

In addition, some modern devices have odd requirements that can only be met through code conversion. An example is a printer that automatically inserts a linefeed after receiving a carriage return. Unless the application calls for double-spaced printing, the printout will not be as desired because most computers send both a carriage return and linefeed to cause printing on a new line.

One solution to this problem is to have the computer convert all linefeeds to nonprinting characters, such as *nulls*. Nulls are supposed to be ignored by receiving devices. They serve as timewasters to help in synchronizing fast computers and slow

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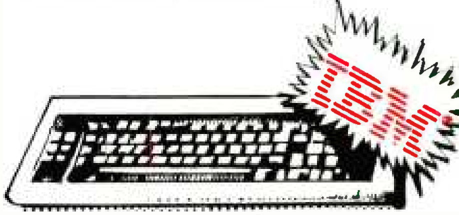

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peripheral devices. A null is ASCII character code 0.

As you can see, character codes are still a source of incompatibility in the world of I/O. If a computer has a programming language that is rich in I/O capability, however, a programmer can overcome character-code incompatibilities.

Outputting Characters

This series is concerned with the interconnection of computers and peripheral devices. Such connections produce systems that process data and perform important tasks. During the development of a system, the programmer communicates with the machine through a programming language. This language could be at the machine level, though that practice is growing less common. The language may be at a high level; that is, a sophisticated programming language provided by the machine's manufacturer.

After the system software is developed, people will have to use it. The computer must be able to interface with people in an effective manner; the people are not concerned with the software running the system. They just want results. Software must make information easy for people to use.

Many different kinds of information are now being used—prices, quantities, voltages, written documents, drawings, and innumerable other forms. Information is the most powerful tool people have. One of the reasons that computers have become such a major factor in current human endeavor is their information-processing power. Yet, for all this capability, computers can only store information in two forms: numbers and nonnumbers.

Prices, inventory quantities, or voltages are not recorded in a computer's memory. It only has numbers with which a program associates these values. My text-editor program doesn't have any pages; it only has character data that the software processes to cause the printing of pages. The software of I/O tells the computer how to accept data from the outside world and how to provide internally stored data to the world in a form that people can understand.

We must first see how information is stored in the computer in order to understand the software of I/O. Numbers are usually stored in something called internal format. The author of the programming language for the computer decided the best way or ways to represent numbers inside the machine. In any internal representation, the 1s and 0s that make up a number are not easy for people to recognize or understand as a number. For example, the number 21 in 16-bit binary is 0000000000010101. In addition, though we have many ways of writing numbers--such as \$2.69, 6.02×10^{23}, and 3.14159--the computer has only a limited number of numeric types.

The most common types are integer and floating point. Whatever type a number is stored in, the com-

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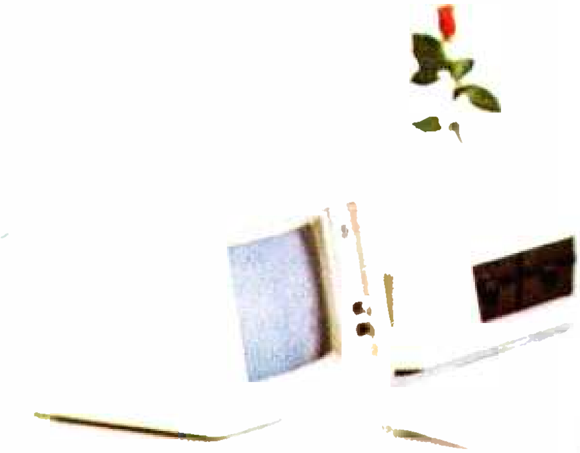

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puter should print the number in a format that makes sense to the user. Bank tellers will laugh if a payroll program prints checks that read 6.02E2 dollars, and wage earners will weep when that number is interpreted as $6.02 instead of $602.

Most high-level languages can make the computer input or output numeric values in the form desired. This capability is called formatting. It may come as a format statement in the language or as a format field within the statement that causes the computer to output information. In either case, the format specification describes exactly how the number is to be output or input—how characters are to be presented to the user.

We can use the above check-writing example to demonstrate formatted I/O. Suppose our program has the following statement in it:

```
210   PRINT Pay
```

That is a very simple program statement. The computer, being the simple machine it is, will print the value of the variable Pay in whatever format the computer is set for at the time the statement is executed. If the machine is in fixed 2 format (two decimal places) and Pay=602, we get the correct "602.00" printed. If the machine were in fixed 0 format, we would get "602," which is close. However, if the machine were in floating-point 9 format, we would get "6.020000000E02." This last printout is not the sort of thing I want to see on my paycheck.

What can we do about this PRINT statement to prevent unacceptable output? A first attempt might be to change the default format of the machine just before the PRINT statement:

```
200   FIXED 2
210   PRINT Pay
```

This approach is taken by programmers who don't know about or don't want to learn about formatting output. The disadvantage of this approach is that the state of the machine is altered, and all subsequent printing will be done in the fixed 2 format unless another FIXED or FLOAT statement is executed. We are also missing the dollar sign that should precede the number on the printout. The program could be changed to:

```
200   FIXED 2
210   PRINT "$",Pay
```

Then we would get "$ 602.00" on the printout. Clearly, the machine is just not understanding what we want. In most languages, the instrument for telling the computer exactly how the number is to be printed is the format field in a PRINT USING statement.

In many languages, changing the program to

```
210   PRINT USING
        "A,000.00";"$",Pay
```

would result in a printout that reads "$602.00," exactly what is desired.

Just as different computer languages have different statements for performing similar functions, format techniques vary widely from language to language. Even differing dialects of languages such as BASIC may vary as to how formatted I/O is performed. The best way to learn how to perform formatted I/O in a given language is to read the manual several times.

Stringing Things Together

As mentioned earlier, not all data can be represented in numeric form. Text, such as this article, is best represented as a linear array of characters. Such arrays are almost always called strings. This data type is useful for storing letters, instructions, and even command sequences for some instruments.

Character codes are used to represent text data in a form that can be transferred from machine to machine. Each character is represented by 5 to 8 bits. As we have seen, ASCII, the most popular code, is a 7-bit code.

Eight bits is a convenient size to store data in most modern digital computers (there are exceptions). Strings are usually composed of 8-bit

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parcels of data. Since ASCII is only 7 bits, 1 bit of each string character is usually wasted.

Input and output of strings is much simpler than for numerics. The internal representation for strings is almost what the printout would look like. The exception to this statement is the terminator, which marks the end of a message.

Input of a string must stop at some point so that data can be processed. The terminating character tells the computer when it has reached the end of the message. A common default terminator is the linefeed character. It is so common that most input statements default to terminating upon receipt of a linefeed. Most output statements automatically append a linefeed at the end of a string output.

As with numeric I/O, everything runs fine until you don't want the defaults any more. Eventually, you will have to read data in from a device that outputs a carriage return as a message terminator. Or perhaps you have a printer that needs an ENQ (Enquiry) character as a terminator instead of a linefeed. Eventually, a situation will arise where the defaults don't work.

What can you do? Use a format statement. If a device requires only a carriage return as a message terminator, the program might contain the following statement:

```
200   PRINT A$
```

This program will output the string A$ and follow it with the carriage return and linefeed characters. Since the device to which you are outputting will terminate one message on the carriage return, it will interpret the linefeed as the start of a new message. In some languages, this may be suppressed by changing the program to:

```
200   PRINT USING
        "#,B",A$,CHR$(13)
```

The "#,B" specifier tells the computer to refrain from adding any embellishments to the string being output. The CHR$(13) is a carriage return, which is the proper terminating character. Again, the formatting capabilities of the language have allowed you to specify exactly what you want the I/O to do.

The software of I/O is an extremely important topic in interfacing. Software is the interface between the programmer and the computer. By understanding how to control system I/O needs through explicit software statements, a programmer can turn a "dumb" computer into a flexible problem solver.

This month, we've seen some of the problems associated with character codes and also some of the software provisions needed to turn stored characters into acceptable printed output. Next month, we'll see how software can take advantage of buffers and interrupts to control input/output. We'll conclude by looking at problems associated with grounds and resulting signal degradation.■

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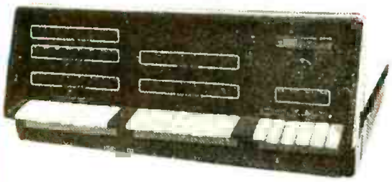

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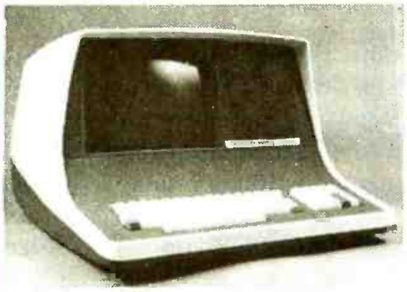

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A General-Purpose I/O Board for the Color Computer

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William Barden Jr.
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In previous articles in this series, I've gone to some extremes to implement input/output (I/O) ports by using the Color Computer's cassette input and output, joystick inputs, and RS-232C port. In this article, I'll show you the "right" way to connect discrete (on/off) lines to the outside world from the Color Computer. It's not that you can't use the other designs to control and monitor outside events—the previous implementations work fine—it's just that you can easily build a general-purpose I/O (GPIO) board that can plug into the Color Computer's ROM connector and provide 24 lines (bits) of I/O. Each of the 24 lines can be programmed for either input or output. The entire board costs less than $25. With a few inexpensive components, you can use it to control sprinkling systems and coffeepots, and to monitor burglar alarms and doorbells. You can even use an *interrupt* with the board to run a real-time, foreground task while also running a BASIC program or other task in the background.

To understand the design of the GPIO board, you must first know how the Color Computer handles read-only memory (ROM) and other input/output operations.

Color Computer I/O Structure

Figure 1 shows a logic diagram of Color Computer I/O. In fact, a large portion of the I/O structure is defined by two chips—the 6809E microprocessor and the synchronous address multiplexer (SAM) chip.

The 6809E is closely related to the Motorola 6800 chip. If you want an in-depth understanding of both, I suggest getting the *Motorola Microprocessors Data Manual*, which contains specifications on both the 6800 and 6809E. I'll capsulize some of the basic information here.

The 6809E is basically an 8-bit microprocessor with some 16-bit processing capability. It has 16 address lines, designated A15 (most significant) through A0 (least significant). The address lines are used to define memory addresses for instruction fetches, access of operands, and reading and writing of data.

It also has eight data lines, designated D7 (most significant) through D0 (least significant). The data lines are used to transfer instruction bytes to the processor during instruction fetch and operand bytes during instruction execution. D7-D0 are also used to transfer I/O data. All data transfers are done one byte at a time.

The 6809E (the "E" designation specifies an external clock) uses two clock inputs, QIN and EIN. The SAM chip (described below) generates the E and Q clock inputs for the 6809E, using a pulse from a crystal oscillator.

The three interrupt inputs to the 6809E are *IRQ, *FIRQ, and *NMI. The asterisk prefix indicates that these are "active low" signals that must go to 0 volts (V) for action.

*IRQ is the primary interrupt input to the 6809E. It signals the 6809E that an interrupt has occurred. If the interrupts are enabled by software, the

About the Author
William Barden Jr. is the author of several books on microcomputers, including Z-80 Microcomputer Design Projects.

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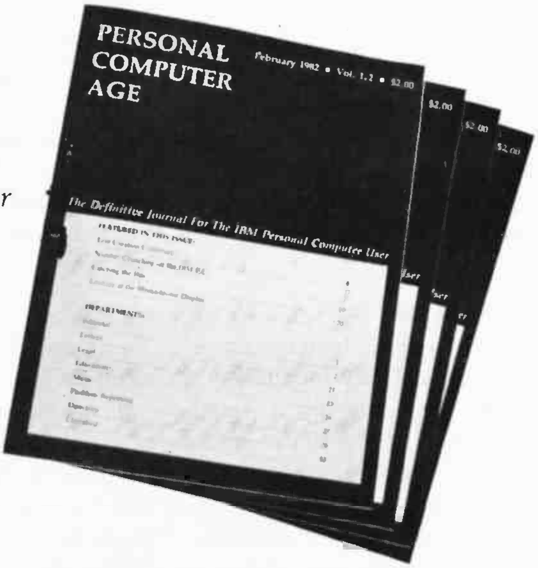

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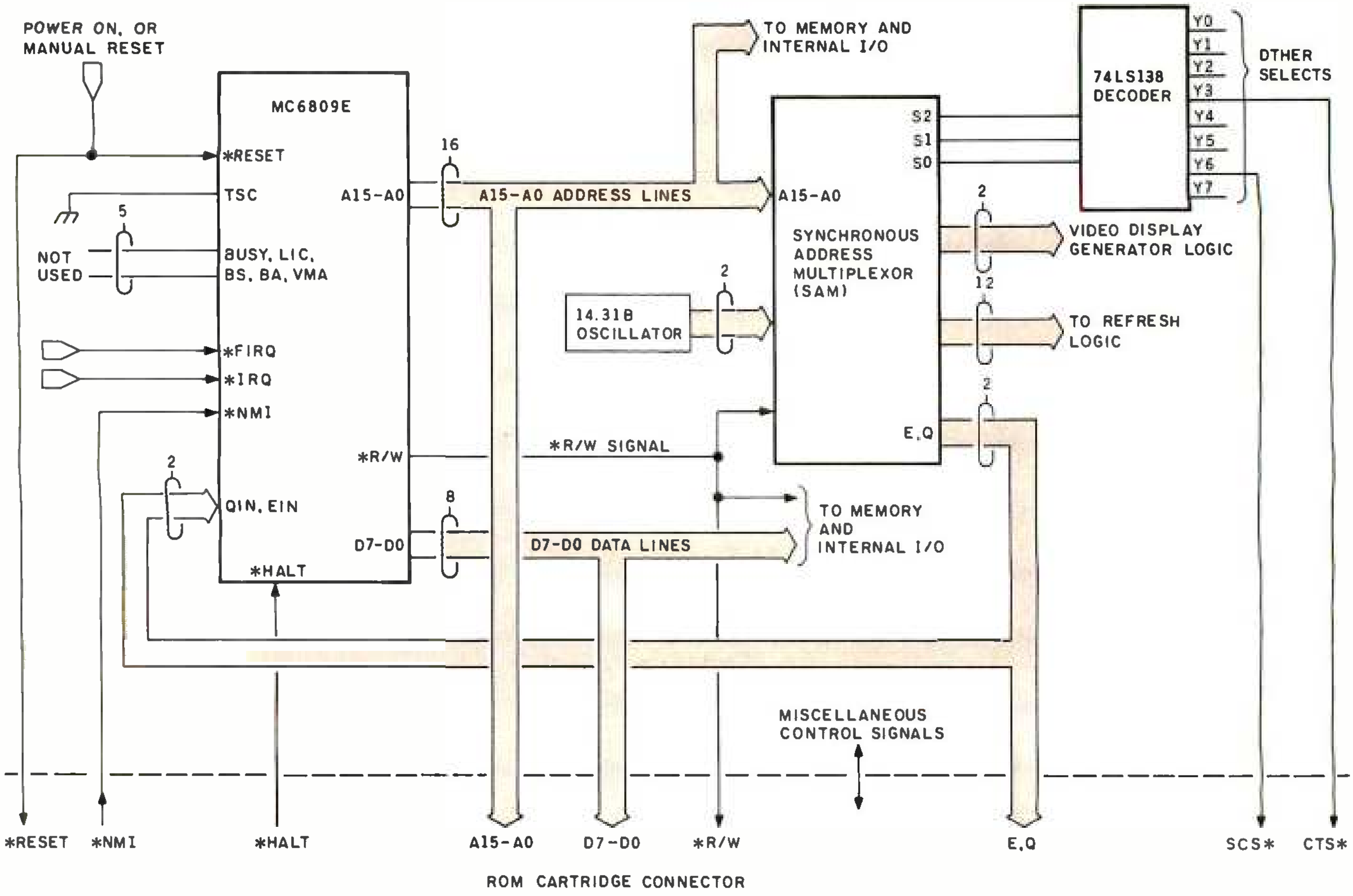

Figure 1: *Color Computer input/output is controlled primarily by the 6809E microprocessor and the synchronous address multiplexer (SAM) integrated circuits. One set of SAM outputs defines the address selection for system RAM, ROM, and I/O devices.*

6809E goes into a predefined interrupt processing routine at the location defined by the contents of a fixed memory location (BFF8-BFF9 hexadecimal in the Color Computer).

The *FIRQ input is a "fast" interrupt that saves less of the "environment" (processor registers) when an FIRQ occurs.

*NMI is a "nonmaskable" interrupt that cannot be disabled. It is generally used for major conditions that must always be detected, such as a real-time clock pulse or an impending power failure.

The *HALT input halts the processor at the end of the current instruction. It is an orderly way to stop the processor and allow control of the program by an outside source. A typical application might be in single-instruction stepping.

The *RESET input is used to initiate a start-up action, either at power-up or when the processor is "hung up" due to improper programming or I/O protocol.

The *R/W output signal tells the external memory or I/O devices whether a read (high, logic 1, or +5 V) or write (low, logic 0, or 0 V) is taking place.

The TSC, BUSY, LIC, BS, BA, and VMA pins are not used in the Color Computer configuration. Many of these signals relate to controlling the address and data bus lines for direct memory access—independent control of system memory for I/O action.

The lines from the processor discussed above constitute part of the system bus that is brought out to the ROM cartridge connector, a 40-pin edge connector on the Color Computer printed-circuit (PC) board.

The SAM Chip

The 6809E works in conjunction with the synchronous address multiplexer (SAM) chip, an important chip in the Color Computer.

The SAM handles refresh of the 4116 dynamic memory in the Color Computer. This type of memory must be accessed periodically to retain the voltage charge and, hence, memory data. Since this refresh is done during times in which no processor memory addressing is taking place, there is no conflict in using the memory address lines.

Another major task of the SAM is to synchronize video-display updates and processor operation. The 6847 video display generator uses random-access read/write memory (RAM) data to update the video display, so it must know when valid data appears from the video-display portion of RAM. The SAM chip integrates the processor and video-display memory addressing.

The timing-signal generation of the SAM was discussed above.

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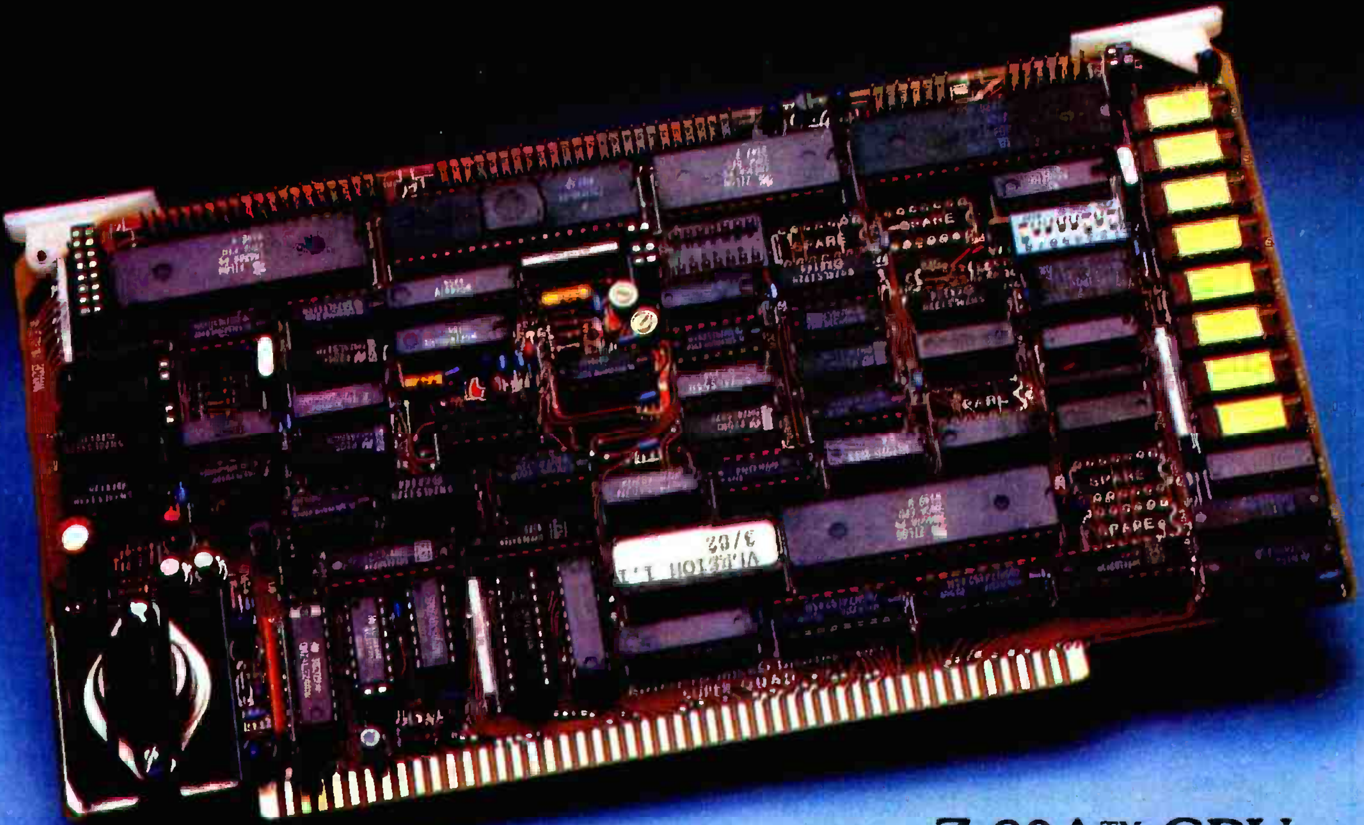

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	2	+12 V	CC	
	9	+5 V	CC	
	33	GND	CC	
	34	GND	CC	
Data	10	D0	CC-6809E	
	11	D1	CC-6809E	
	12	D2	CC-6809E	
	13	D3	CC-6809E	Data Bus
	14	D4	CC-6809E	
	15	D5	CC-6809E	
	16	D6	CC-6809E	
	17	D7	CC-6809E	
Address	19	A0	CC-6809E	
	20	A1	CC-6809E	
	21	A2	CC-6809E	
	22	A3	CC-6809E	
	23	A4	CC-6809E	
	24	A5	CC-6809E	
	25	A6	CC-6809E	
	26	A7	CC-6809E	Address Bus
	27	A8	CC-6809E	
	28	A9	CC-6809E	
	29	A10	CC-6809E	
	30	A11	CC-6809E	
	31	A12	CC-6809E	
	37	A13	CC-6809E	
	38	A14	CC-6809E	
	39	A15	CC-6809E	
Clock	6	E	CC-SAM	Clock Signals
	7	Q	CC-SAM	
Select	32	CTS*	CC-74LS138	ROM or I/O Select
	36	SCS*	CC-74LS138	
	40	SLENB*	External	Decode Disable
Other	3	HALT*	External	Halts Processor
	4	NMI*	External	NMI Interrupt
	5	RESET*	CC	Power-on or Reset
	8	CART	External	Cartridge Sense
	18	R/W*	CC-6809E	Read/Write Signal
	35	SND	External	External Sound

CC = Color Computer
External = Input to CC

Table 1: *Signals available on the Color Computer ROM cartridge port.*

The last function of the SAM is to decode and control the memory mapping of the system. Three signals, S2, S1, and S0, are output from the SAM into a 74LS138 decoder chip. Only one of the eight outputs (Y0-Y7) of the 74LS138 is active (low) at any time. The one chosen depends upon the states of S2, S1, and S0, which in turn depend upon the A15-A0 inputs.

If Y0 is active, RAM from address 0000-7FFF hexadecimal is being addressed. (Unless otherwise noted, all addresses are in hexadecimal form.) If Y1 or Y2 is active, ROM area 8000-9FFF or A000-BFFF is being addressed. If Y3 is active, cartridge ROM at C000 and up is being addressed (CTS*). If Y4 is active, the PIA addresses at locations FF00-FF1F are being addressed. If Y5 is active, the PIA addresses at locations FF20-FF3F are being addressed. If Y6 is active, memory locations FF40-FF5F are being addressed. These locations are nonexistent in the Color Computer, but come out to a ROM cartridge pin (SCS*) and can be used in external logic. Signal Y7 is not used.

ROM Cartridge Signals

The ROM cartridge connector uses 40 pins with signals from the 6809E processor, SAM, power supplies, and some additional logic.

The ROM cartridge port is more than just a port that enables the Color Computer to execute a program in ROM or erasable programmable read-only memory (EPROM); it is a general-purpose port that enables interfacing RAM memory or I/O devices of many types.

Table 1 lists the ROM cartridge-port pins, signal names, source, and description.

Signals D7-D0 and A15-A0 are the data and address lines from the processor, respectively. These are essential in connecting memory or I/O devices to the system. Bringing out all 16 address lines allows any of the 65,536 addresses in the 6809E addressing space to be specified.

The *RESET signal to the processor is also brought out on pin 5 of the ROM cartridge port. A power-on or manual reset can reset an external device with this signal, in addition to causing the processor reset.

The CART and *HALT processor inputs are generated from external logic connected to the ROM cartridge port. The EIN and QIN clock outputs from the SAM are also sent to pins 6 and 7 of the ROM cartridge port. I'll soon explain how these signals work in the cartridge ROM.

The *R/W signal from the processor is brought out on pin 18 of the connector. This signal is necessary to define whether a read or write should be done during I/O between an external device and the system.

The *NMI signal to the processor is generated only by external logic. It can be used to cause a nonmaskable interrupt to the processor, but is not used in the standard ROM configuration.

The SCS* signal is the select signal from the 74LS138 chip that indicates that an address in the range FF40-FF5F is being used. This spare address is not normally used in Radio Shack software, although I'll be using it in this design.

The SLENB* signal is generated by logic connected to the ROM cartridge port. Bringing this input low (0 V)

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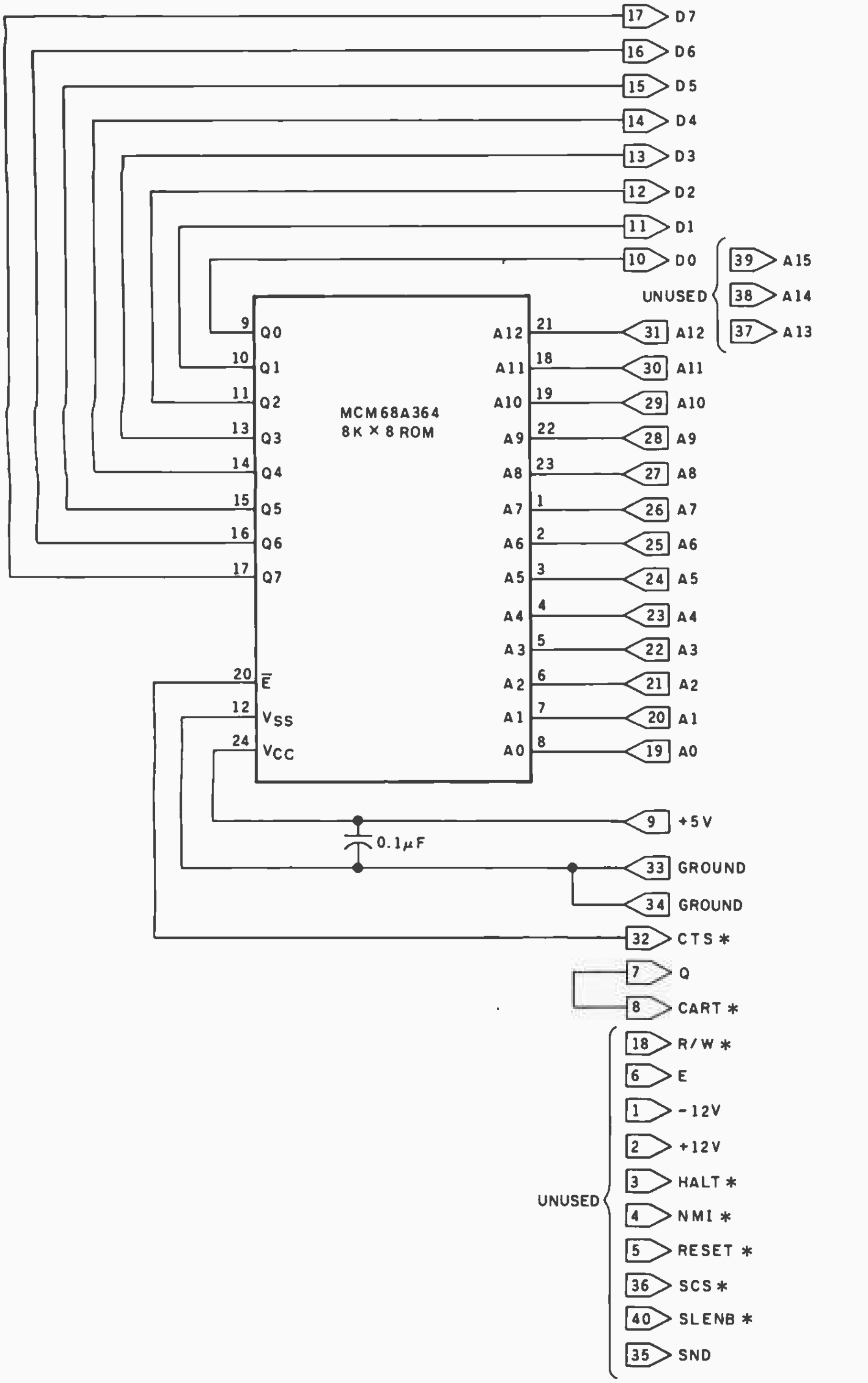

Figure 2: *A typical ROM cartridge contains a program in up to 8K bytes of ROM. Minimal logic is required in addition to the ROM chip itself.*

disables the address decoding by the 74LS138 (Y0-Y7 remain inactive). This signal enables the device connected to the cartridge port to "turn off" all internal devices. It is not normally used in Radio Shack software.

The SND input from logic connected to the ROM cartridge port enables an external sound to be routed through the system to television audio.

ROM Operation

A typical ROM plug-in cartridge is shown in figure 2. The data lines D7-D0 connect to the data lines of the ROM memory.

When any address in the range of C000-DFFF is addressed by the processor, the CTS* line goes active. The CTS* signal from the 74LS138 address decoder goes to the ROM cartridge and enables the ROM. The actual ROM address for the ROM chips is defined by the state of address lines A12-A0. These 13 lines go to the address inputs of the ROM chips. The ROMs may be any size up to 8K bytes, requiring 13 address bits, which are supplied by the remainder of the C000-DFFF address.

No *R/W signal is required in the ROM case, since by definition a ROM must always be a read device.

The ROM plug-in cartridge routes the Q signal from the SAM to the CART input. This causes an FIRQ interrupt that results in a hardware branch to the address found at FFF6-FFF7 (BFF6-BFF7 in the Color Computer). Normal Radio Shack software at this address contains an FIRQ interrupt processing routine that transfers control to the program found in the ROM.

I/O Device Operation

I/O operation is similar to memory addressing as used in the ROM cartridge or in RAM addressing. I/O in the 6809E is memory mapped. This means that an input/output device is treated just as another memory location, rather than using separate I/O instructions.

Reading 8 bits of data from an I/O device is done by an "LDA ADDRESS" or similar instruction; "ADDRESS" may be a memory location or an I/O device. The programmer must know how the 65,536 memory addresses in the addressing space of the 6809E are mapped—which addresses are RAM, which are ROM, and which are I/O devices.

Writing is handled in similar fashion. An "STA ADDRESS" can store 8 bits of data either to a memory location or to an I/O device, depending on how the system is mapped.

PEEK and POKE instructions in BASIC operate in identical fashion to LDA and STA; the two commands can read or write data from either memory or I/O devices.

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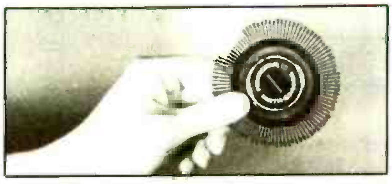

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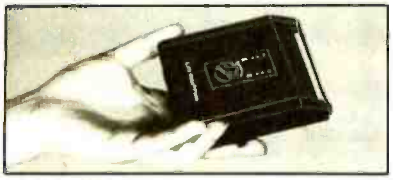

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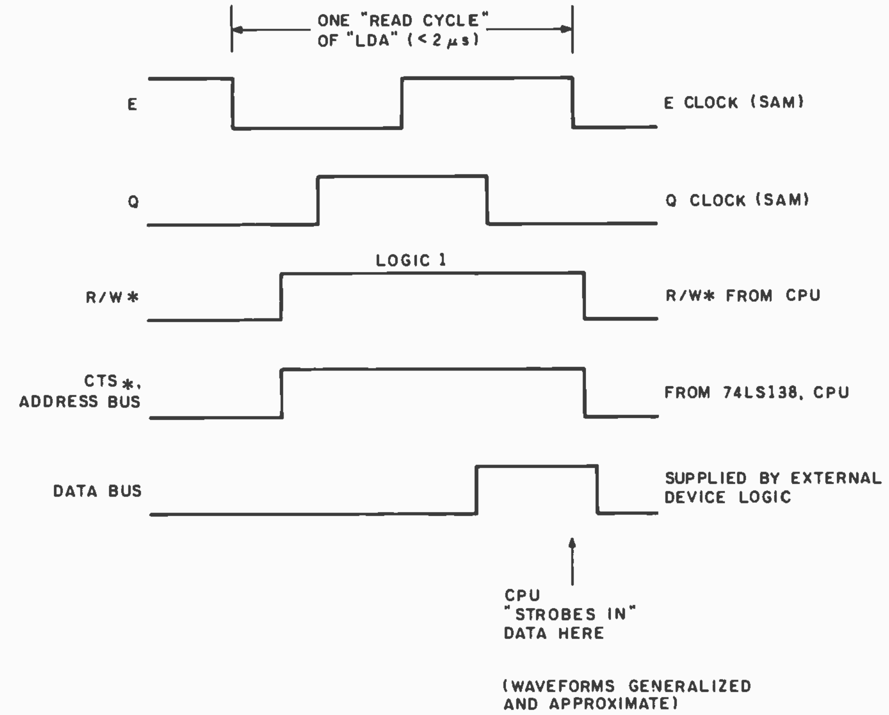

Figure 3: *Generalized input for transfer of data from an external I/O device. Data is supplied by the I/O device after detection of the CTS* and an R/W* signal of 1.*

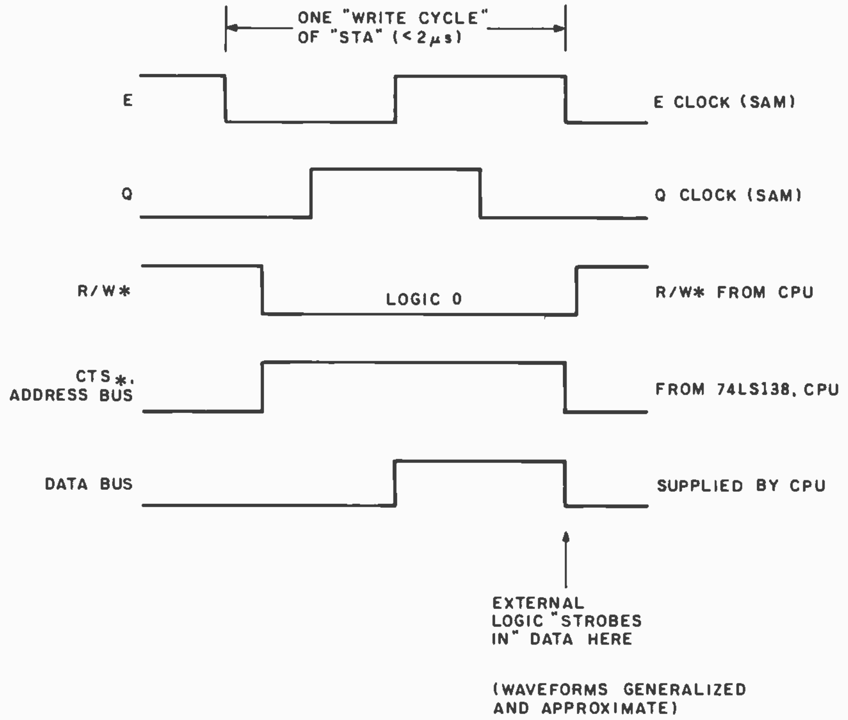

Figure 4: *Generalized output for transfer of data to an external I/O device. Data is supplied to the I/O device along with CTS* and an R/W* signal of 0.*

General Input Operation

In general, reading from an external device plugged into the ROM cartridge connector would proceed as follows:

1. An LDA $*xxxx* or PEEK &H*xxxx* would be executed by the program, where *xxxx* is an address in the range C000-BFFF.
2. The CTS* signal would become active and the address lines to the cartridge would contain the entire *xxxx* address.
3. The *R/W line would, at a certain point, go to a logic 1, indicating a read.
4. The external I/O controller logic would detect the CTS* and *R/W, and deduce that a read instruction was being executed by the processor.
5. The controller logic would supply 8 bits of data on the data bus lines.
6. The processor logic would strobe in the data from the data bus.

In fact, this operation would occur very rapidly over a portion of one LDA instruction, as shown in figure 3.

Notice that the controller did not use the address lines. All it needed to know was that it was being addressed, and this was apparent by the CTS* line (the controller's address is the address range C000-DFFF). Either the CTS* or SCS* signals could have been used as the controller's address. In fact, the SCS* is probably better, since it defines a smaller range of addresses, more suitable for an I/O device. In this case, the controller's address would have been FF40-FF5F.

If the controller had to pass many different types of data, it might well decode all or a portion of the address lines A15-A0. It depends upon the application. A paper-tape reader, for example, might use address FF40 as the address for "reading the next byte of data from paper tape " and FF41 as the address for "reading the status of the paper tape (jammed, moving, etc.)." It depends upon the complexity of the I/O device.

General Output Operation

In general, writing to an I/O device

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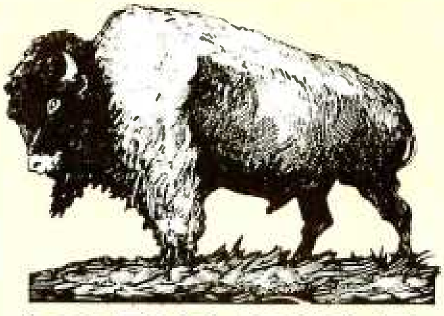

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plugged into the ROM cartridge port would proceed as follows:

1. An STA $*xxxx* or POKE &H*xxxx*,*v* would be executed, where *xxxx* is the ROM cartridge-port address of C000-DFFF and *v* is the 8-bit value to be transferred.
2. The CTS* signal would become active and the address lines to the cartridge would contain the entire *xxxx* address.
3. The *R/W line would, at a certain point, go to a logic 0, indicating a write. The processor would supply the 8 bits of data on the data bus lines.
4. The external I/O controller logic would detect the CTS* and *R/W, and deduce that a write instruction was being executed by the processor.
5. The controller logic would strobe in the data from the data bus.

All of this would occur in the space of a single "STA" instruction, even if a BASIC POKE was involved (see figure 4). Again, additional address-line decoding might be required, and it would be convenient to use the SCS* signal in place of the CTS*.

A General-Purpose I/O Board

Figure 5 shows the logic diagram of a general-purpose I/O (GPIO) board that plugs into the ROM cartridge connector. It operates in a similar fashion to the general input/output described above. The board is built around an Intel 8255 programmable peripheral interface (PPI). It uses three 74LS240 bus buffers to provide higher current-drive capability to 24 lines, 8 of which are inputs and 16 of which are outputs.

The 8255 PPI

The 8255 is a general-purpose I/O device that operates in several modes. I've chosen the simplest mode for this application, the mode in which each of three sets of lines can be programmed to be inputs or outputs. In this case, I've arbitrarily made the "A" and "B" lines outputs, and the "C" lines inputs, although the sets could have been either inputs or outputs by simply outputting the proper control byte.

Many of the signals previously described are used in this design.

The addresses of the device are FF40, FF41, FF42, and FF43. The SCS* signal enables the 8255 (CS is chip select), and address lines A1 and A0 choose the two lower address bits.

Since the 8255 requires a write signal of 0 (WR) and a read signal of 0 (RD), I've added some additional logic (74LS00) to provide the proper signal from the basic R/W* signal.

The 8255 is cleared by a RESET signal of logic 1; another section of the 74LS00 changes the active low RESET* from the 6809E to an active high signal.

The 24 lines go to three 74LS240 chips. These are octal buffers that provide up to 40 milliamps (mA) of "sink" current and invert the 8255 signal.

Software for the GPIO Board

Programming the board is easy. First, the 8255 must be initialized to mode 0, the simplest I/O mode that it can use. This is done by outputting a value of decimal 137 to address FF43 hexadecimal (the 8255 control register), either by a BASIC POKE 65347,137 or by an assembly-language instruction. This initialization should be done on power-up or after every system reset.

To write to port A or B, do a POKE 65344,*v* or a POKE 65345,*v*, with *v* set to the 8-bit value for lines PX7-PX0. The value will be latched into the 8255 and remain on the outputs until overwritten by a new value. To set lines PB7, PB6, and PB0, for example, do a POKE 65345,193. The outputs of the 74LS240 will be inverted.

To read port C, do a PEEK (65346). The value will be returned as an 8-bit number, corresponding to lines PC7-PC0. The inputs from the 74LS240 are inverted.

Using the GPIO Board

A small reed relay can be driven by a 74LS240 output. The maximum current required to pull in the relay cannot exceed 40 mA. Radio Shack relays (275-228) were used in the pro-

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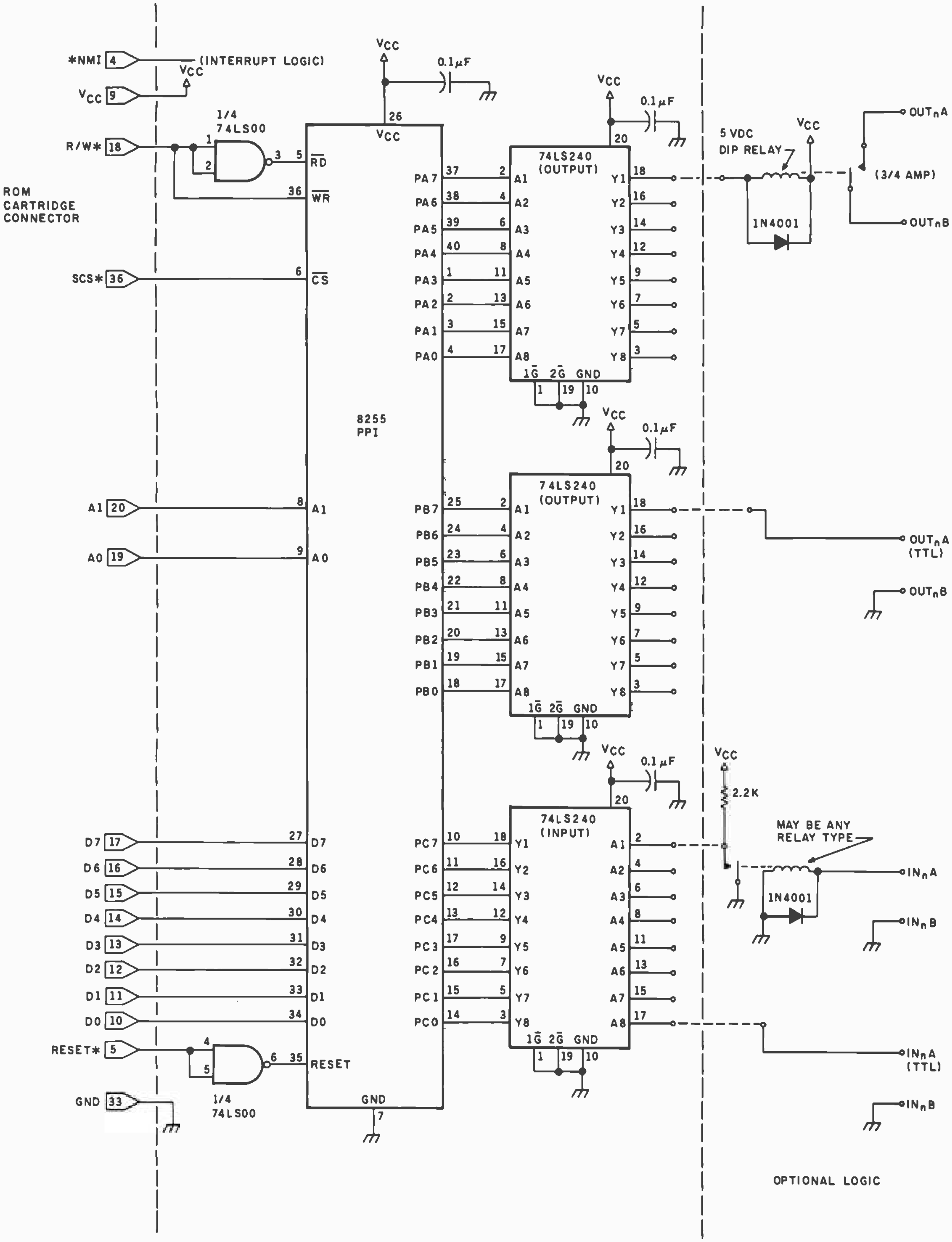

Figure 5: *The general-purpose I/O board consists of a programmable peripheral interface (PPI) chip, 3 bus-driver chips, and minor logic conversion. The PPI provides 24 discrete lines that can be used to drive relays or other devices. In this configuration, 16 of the lines are outputs and 8 are inputs.*

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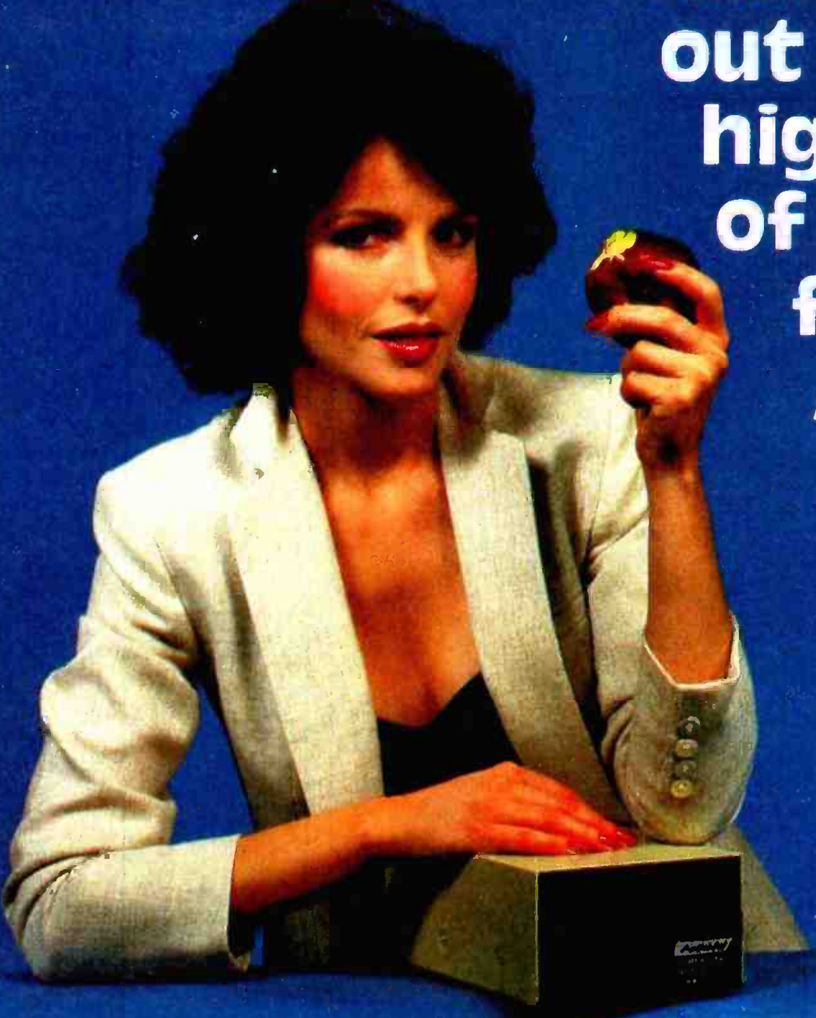

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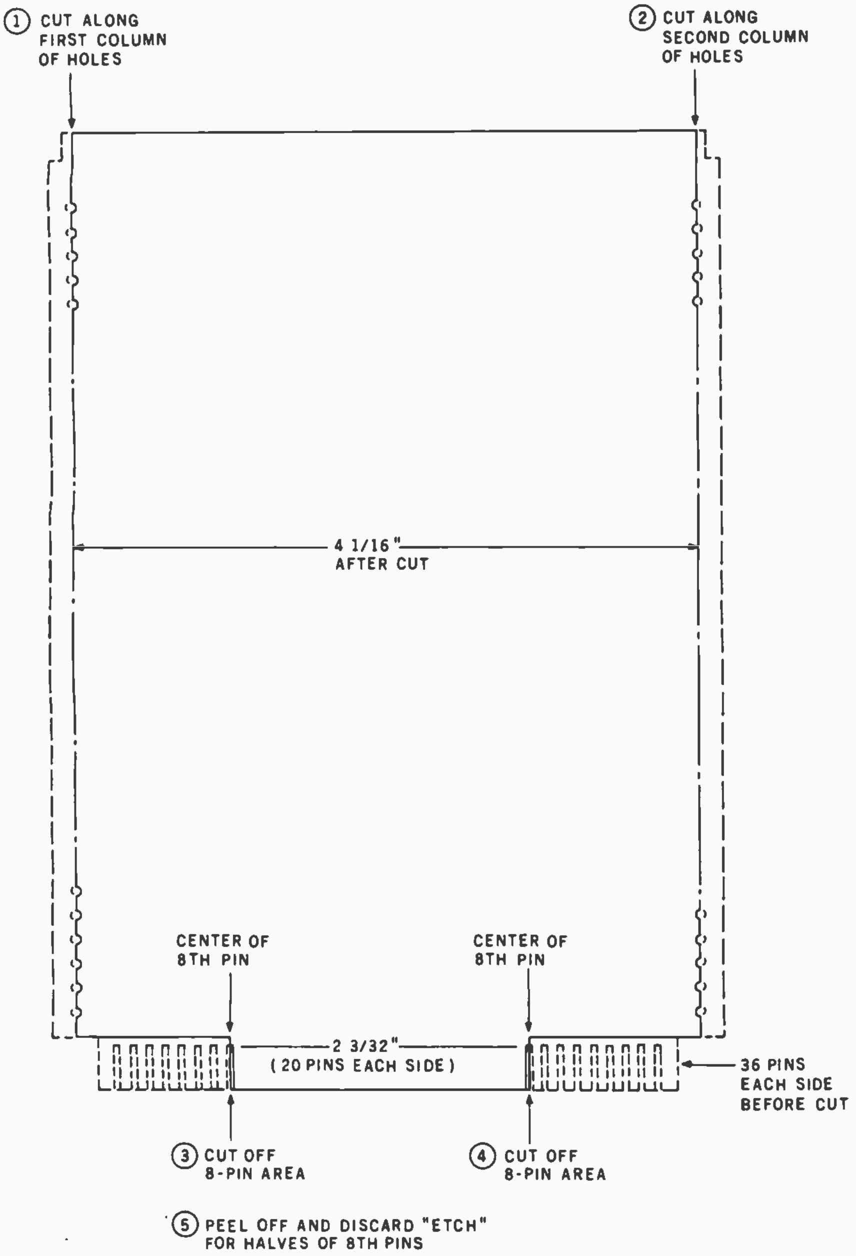

Figure 6: *A Vector Electronics 3719-1 DIP plugboard can be cut to fit the 40-pin edge connector and cutout for the Color Computer ROM cartridge port.*

From	To	Signal
CC-18	74LS00-1	R/W*
74LS00-1	74LS00-2	R/$\overline{\text{W}}$*
74LS00-3	8255-5	$\overline{\text{RD}}$
74LS00-1	8255-36	$\overline{\text{WR}}$
CC-36	8255-6	SCS*/$\overline{\text{CS}}$
CC-20	8255-8	A1
CC-19	8255-9	A0
CC-17	8255-27	D7
CC-16	-28	D6
CC-15	-29	D5
CC-14	-30	D4
CC-13	-31	D3
CC-12	-32	D2
CC-11	-33	D1
CC-10	-34	D0
CC-5	74LS00-4	RESET*
74LS00-4	74LS00-5	RESET*
74LS00-6	8255-35	RESET
CC-9	V_{cc} Bus	V_{cc}
CC-33	GND Bus	GND
8255-37	74LS240-2	PA7
-38	-4	6
-39	-6	5
-40	-8	4
-1	-11	3
-2	-13	2
-3	-15	1
-4	-17	0
8255-25	74LS240-2	PB7
-24	-4	6
-23	-6	5
-22	-8	4
-21	-11	3
-20	-13	2
-19	-15	1
-18	-17	0
8255-10	74LS240-18	PC7
-11	-16	6
-12	-14	5
-13	-12	4
-17	-9	3
-16	-7	2
-15	-5	1
-14	-3	0

To V_{cc} Bus:
74LS00-14
8255-26
74LS240-20 (3)

To GND Bus:
74LS00-7
8255-7
74LS240-1 (3)
74LS240-19 (3)
74LS240-10 (3)

0.1-μF capacitors between:
V_{cc} and GND Buses
V_{cc} and GND Pins on 5 IC Sockets

Table 2: *General-purpose I/O board wire list.*

totype, drawing 22.5 mA. These relays will handle up to ¾ ampere (A) on the contacts and can be used to drive a larger relay or small load at a local or remote location.

On the input side, the Radio Shack relay can be used in reverse. The contact closure pulls down a signal input from logic 1 to 0, as shown in figure 5. The control voltage can be 5 to 6 V DC from a remote location.

The output side can also drive any other transistor-transistor logic (TTL) circuit, as long as the length of wire from the 74LS240 output to TTL input is kept shorter than three or four feet.

Devices such as optoisolators or solid-state relays can be driven by the outputs to control virtually any device.

Construction of the GPIO Board

The board is constructed on a Vector Electronics 3719-1 DIP plugboard. This board is not available at Radio Shack stores, but is probably one of the most popular "prototype" boards around.

The Vector board comes with a 36-position edge connector, as shown in figure 6. Cut the board as shown in

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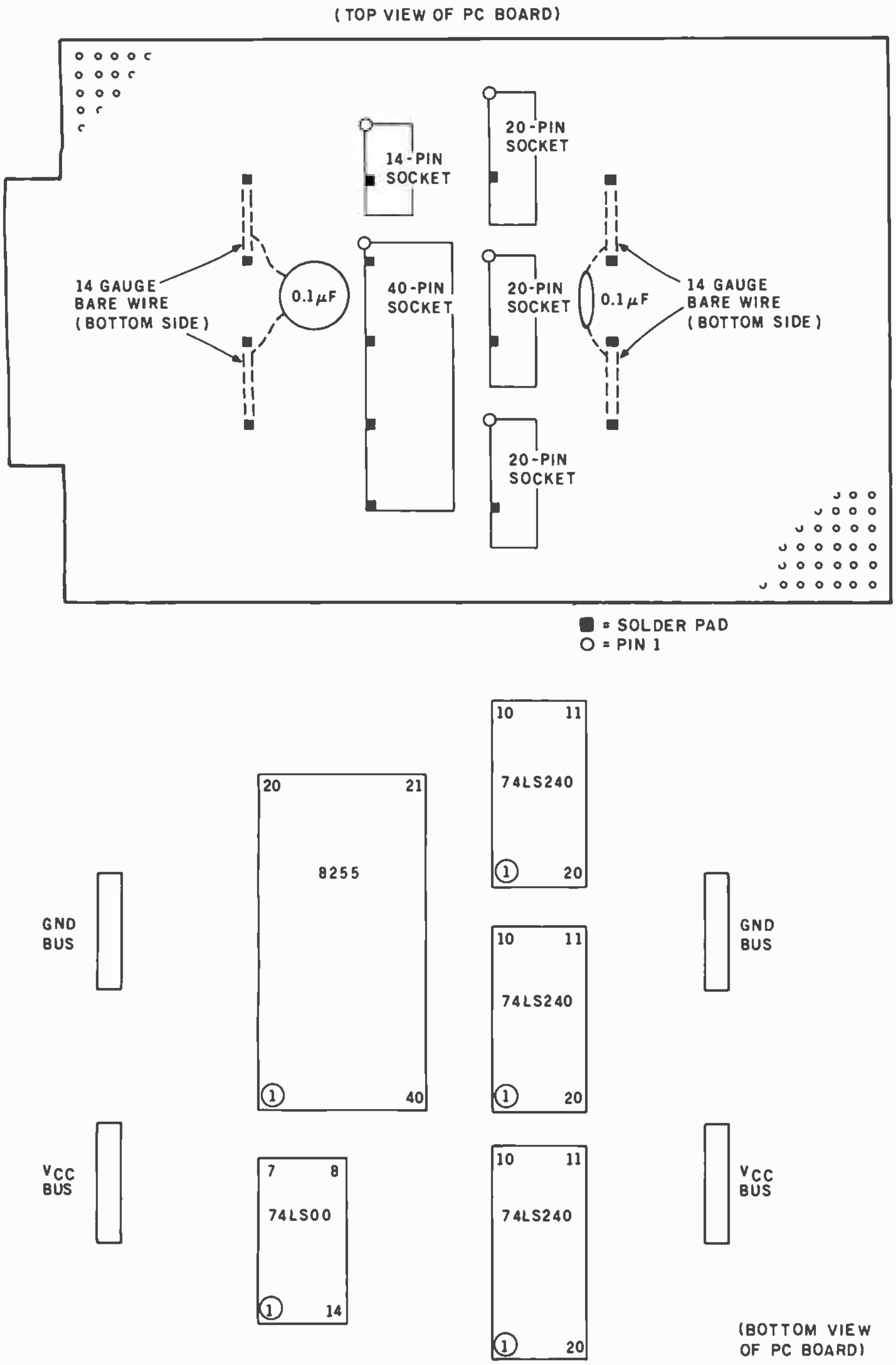

Figure 7: *GPIO board component mounting. Five IC sockets and two sets of buses constitute the major mechanical construction of the board.*

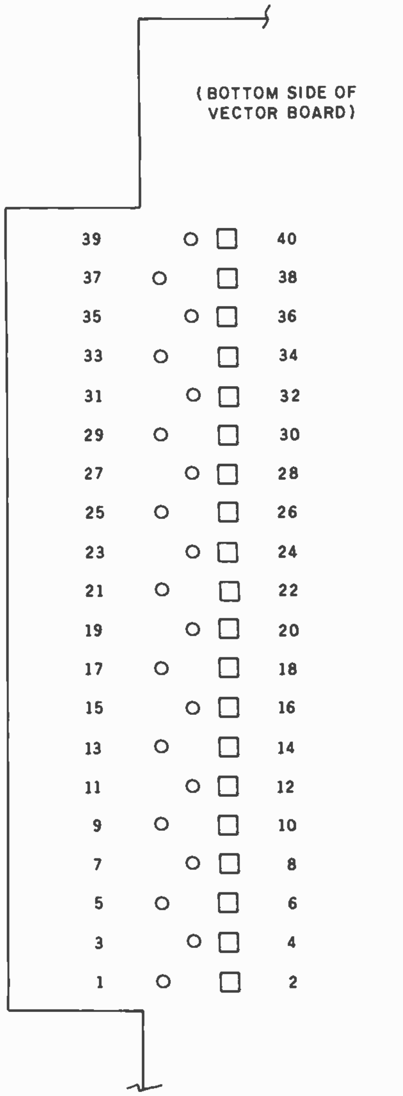

Figure 8: *GPIO pin connections viewed from the bottom side.*

the figure so that it will be able to fit into the ROM cartridge hole and connector.

Once the board is cut, mount five IC sockets (see figure 7). At least one pin of each socket should be soldered to a copper pad on the board. Wiring will provide additional mechanical support for the sockets.

Four buses are constructed out of 14-gauge bare wire, as shown in the figure. Enlarge the holes slightly to pass the wire and solder the ends to the solder pads on the top side of the board. Two 0.1-microfarad (μF) disk capacitors are mounted between each set of buses.

After mounting the IC sockets and buses, wire the board as shown in table 2. I used wire-wrap wire (30 AWG) for all logic connections and larger-gauge "hook-up" wire for power and bus connections. The wire-wrap wire can be soldered to the IC socket pins, or, if you wish, you can wire-wrap the pins. Edge-connector connections are soldered.

Add five additional 0.1-μF disk capacitors between the V_{cc} and ground pins of each socket for noise immunity.

The pin-position numbering for the 40 pins of the edge connector is shown in figure 8. Pin numbering for the board and Color Computer connector is shown in figure 9.

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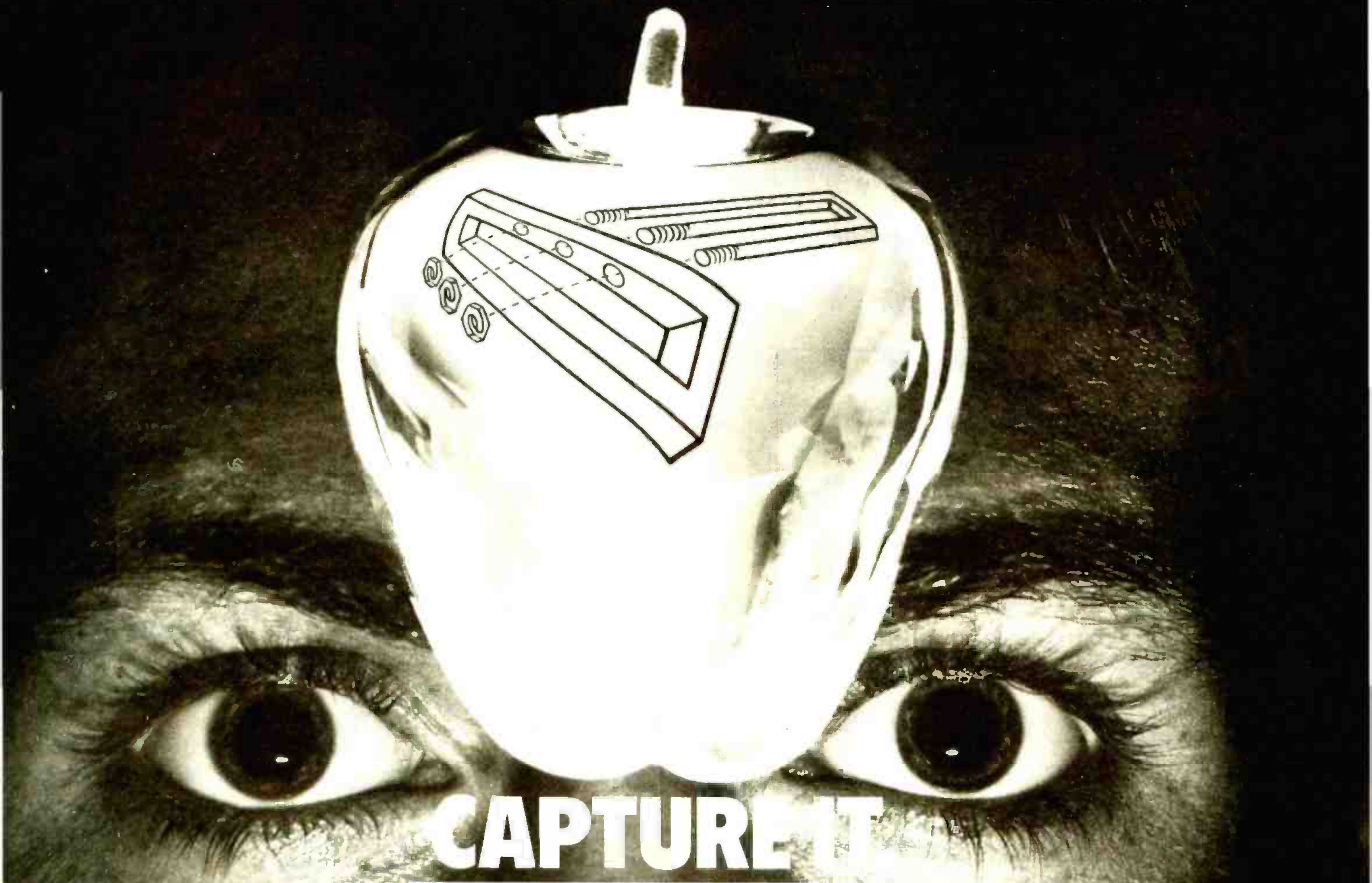

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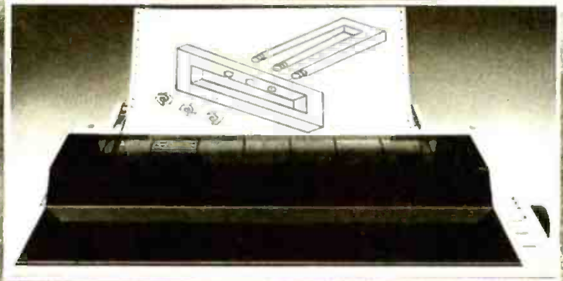

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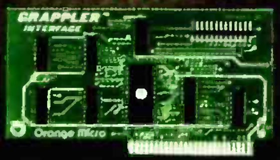

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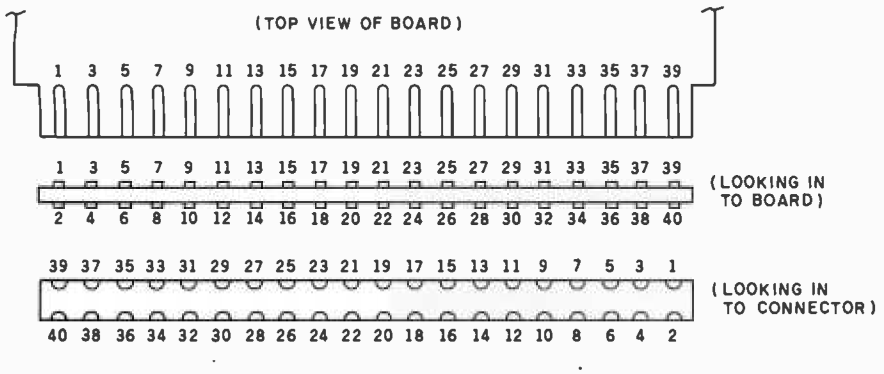

Figure 9: *GPIO and Color Computer cartridge-connector pin designations.*

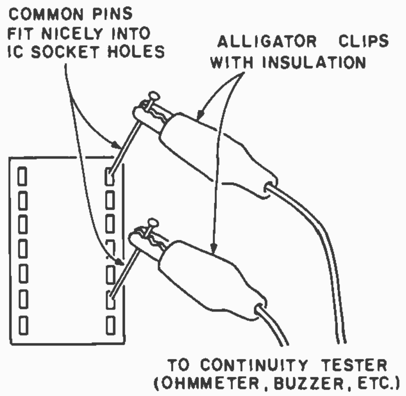

Figure 10: *The GPIO may be conveniently "buzzed out" with a continuity tester or ohmmeter and two common pins that fit into IC socket holes.*

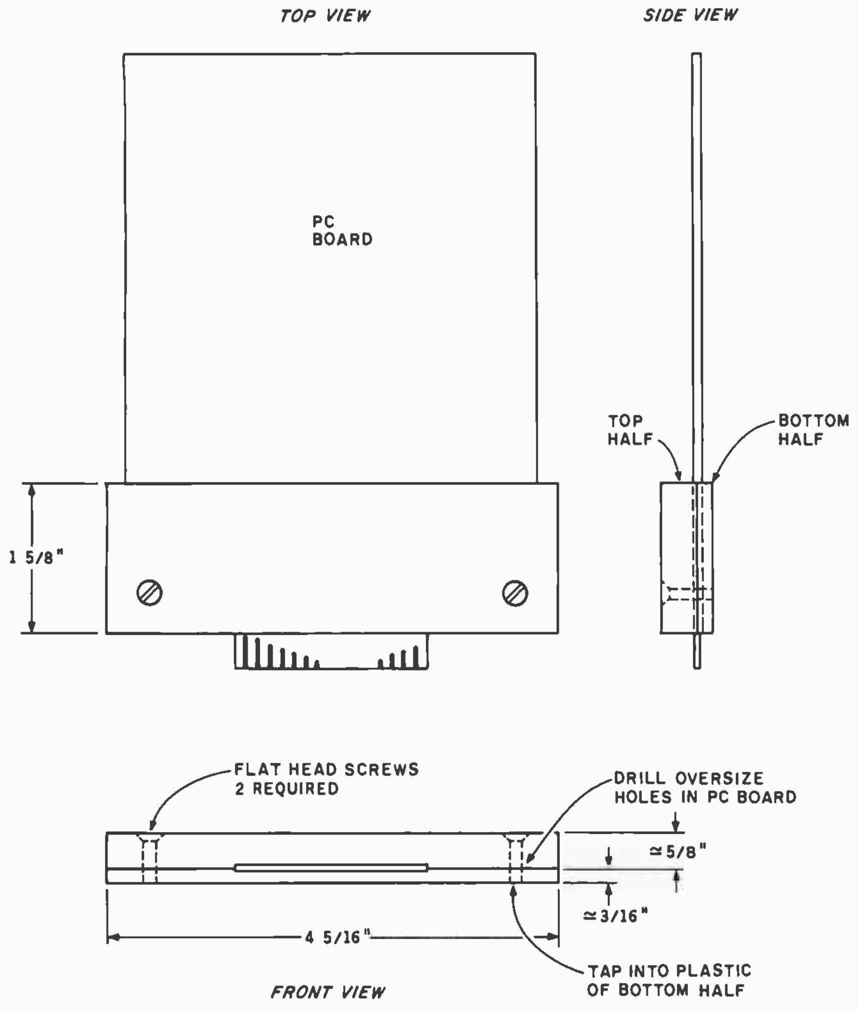

Figure 11: *The GPIO protective cover is made from two cut-down plastic cassette-tape cases. The cover holds the GPIO board in place and acts as a guide in inserting the board.*

After wiring, check all connections by "buzzing out" the sockets with a continuity tester. I use two common pins to get into the IC socket holes, as shown in figure 10.

Once the board connections have been checked out, you can add the protective cover. By a strange coincidence, the Color Computer ROM cartridge hole is almost an exact match for a common cassette-tape case inserted widthwise. Two covers can be sacrificed to make a workable cover that will align the board properly in the ROM cartridge hole (see figure 11).

The plastic on the case is easy to work with, and I found that a sharp razor blade will cut through the plastic quite easily, albeit with a dozen passes. File off the cut edges for aesthetics. Add two screws to hold the cover in place.

Testing the Board

Turn off the Color Computer and insert the board into the cartridge cutout. The PC board should go in easily and the cover should clear the sides with no binding.

Enter the program shown in listing 1. The first part of this program prints the input lines and allows entry of output data. The second part toggles the output lines on and off at a slow rate. You can test the outputs by using a common light-emitting diode (LED) with a current-limiting resistor, as shown in figure 12. Inputs may be carefully grounded as shown in the figure; you should see the values change on the display as you vary the inputs.

The relay connections for both input and output are shown in figure 13.

Using the Nonmaskable Interrupt

The NMI* signal on pin 4 can be generated on the GPIO board quite easily by grounding pin 4. When this signal goes to ground (logic 0), it causes the following hardware actions to occur:

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Listing 1: *This test driver for the GPIO board allows manual entry of output values or a slow-speed toggling of output lines.*

```
100 ' TEST DRIVER FOR GENERAL-PURPOSE I/O
110 POKE 65347,137
120 POKE 65344,0
130 POKE 65345,0
140 PRINT PEEK(65346)
150 IF INKEY$="" THEN GOTO 140
160 INPUT A,B
170 POKE 65344,A
180 POKE 65345,B
190 GOTO 140
1000 POKE 65347,137
1010 POKE 65344,0
1020 POKE 65345,0
1030 FOR I=0 TO 1000:NEXT I
1040 POKE 65344,255
1050 POKE 65345,255
1060 FOR I=0 TO 1000:NEXT I
1070 GOTO 1010
```

Listing 2: *This simple interrupt-handling program increments location 3FFF hexadecimal for each NMI interrupt received.*

```
100 ' NMI INTERRUPT EXERCISER
110 POKE &H109,126:POKE &H10A,63:POKE &H10B,240
120 POKE &H3FF0,124:POKE &H3FF1,63:POKE &H3FF2,255
130 POKE &H3FF3,59
140 POKE &H3FFF,0
150 PRINT PEEK(&H3FFF)
160 GOTO 150
```

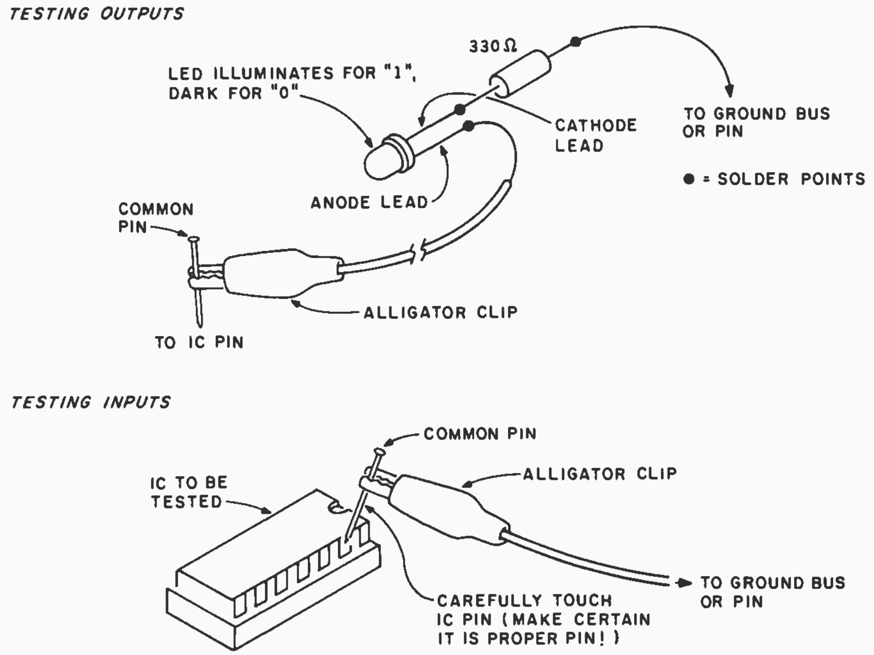

Figure 12: *Outputs are tested by a common LED in series with a 330-ohm resistor. The LED should illuminate for a logic 1 output. Inputs are tested by grounding the input pins and observing the value read.*

1. The processor completes the current instruction.
2. The processor saves the contents of the program counter in the stack.
3. If the "E" bit is currently set in the condition codes, all the processor registers are saved in the stack. If the "E" bit is not set, only the condition codes are saved in the stack.
4. The processor reads the NMI vector address from memory location FFFC-FFFD. It then transfers control to the address found at that location.

In the Color Computer, the NMI vector is actually at location BFFC-BFFD, which normally holds address 0109. Locations 0109, 010A, and 010B would normally contain a jump instruction to the machine-language NMI processing routine in RAM. The NMI processing routine would handle the NMI and then, as a last instruction, perform an "RTI," or return from interrupt, instruction. This would return processing to the interruption point, which could be in the BASIC interpreter or in a machine-language program in RAM.

I can't provide a complete course in reentrant interrupt processing, but I can give you a flavor of what is involved in using the NMI. The program in listing 2 shows a simple BASIC program that pokes a "JMP $3FF0" instruction into locations 0109-01B and "INC $3FFF" and "RTI" instructions into locations 3FF0-3FF3. This short NMI processing program will increment location 3FFF for every NMI.

To see the effects of the NMI, connect a short piece of wire from pin 4, with the opposite end loose. Key in the program after first protecting high RAM by a "CLEAR 200, &H3FEF". Run the BASIC program and ground the NMI pin by grounding the wire on the ground bus or ground pin.

You'll see the count in location 3FFF change rapidly. Each time it changes by one, an NMI interrupt has occurred, and the NMI interrupt processing routine at location 3FF0 has been entered. The count changes by more than one because the connec-

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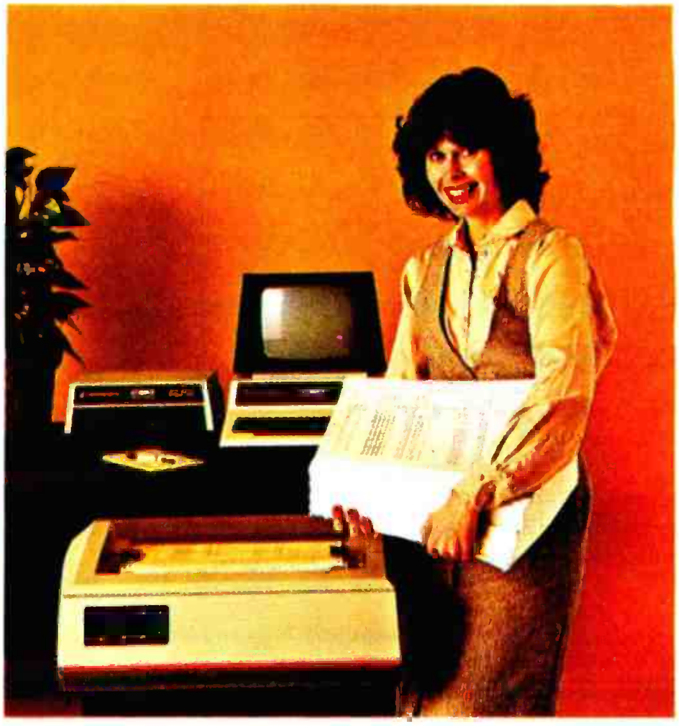

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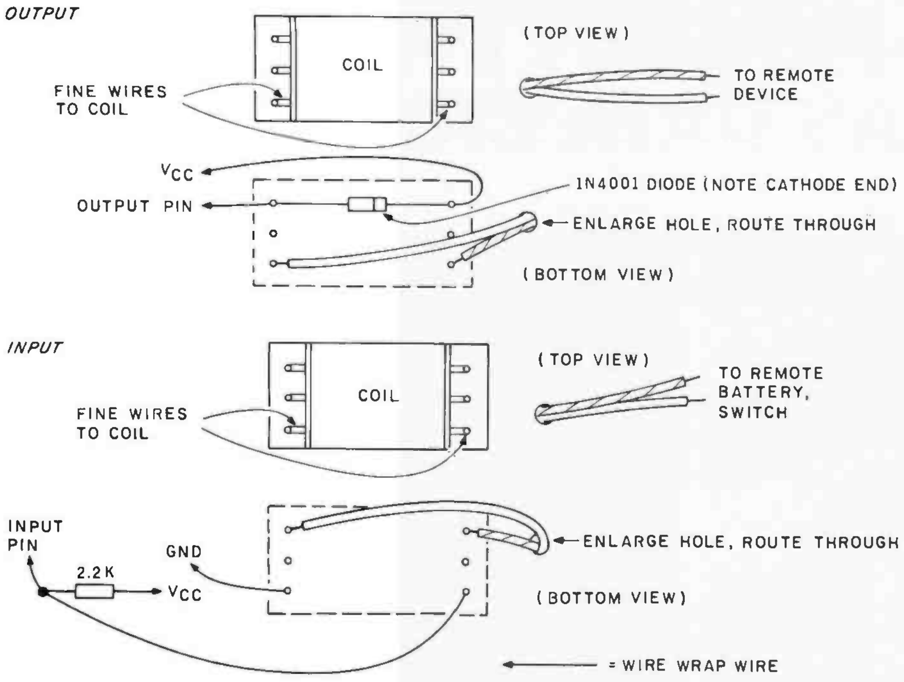

Figure 13: *Radio Shack 275-228 reed relay can be used either for output driving or for current-driven inputs. Although the relays are inelegant, they do prevent problems with noise over long cable runs.*

tion to ground has not been "debounced"—many momentary contacts have occurred in connecting the wire to ground, and each one has generated an NMI.

The NMI* input can indeed be used for real-time processing by providing a single pulse from a logic 1 to a logic 0, and by a relevant NMI processing routine in assembly-language code. As the textbooks state, "This will be left up to the student as an exercise!"■

References

1. Ahrens, Tim, Jack Browne, and Hunter Scales. "What's Inside Radio Shack's Color Computer?" BYTE, March 1981, p. 90.
2. *Motorola Microprocessors Data Manual* (available from Motorola Semiconductor Products Inc., POB 20924, Phoenix, AZ 85036).

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Uh...three legends.

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Logical seeking function	X	X	X	X	X	X
Disposable print head	X	X	X	X	X	X
Speed: 80 CPS	X	X	X	X	X	X
Matrix: 9 x 9	X	X	X	X	X	X
Selectable paper feed			X		X	X
PAPER HANDLING FUNCTIONS						
Line spacing to n/216		X		X	X	X
Programmable form length	X	X	X	X	X	X
Programmable horizontal tabs	X	X	X	X	X	X
Skip over perforation			X	X	X	X
PRINT MODES AND CHARACTER FONTS						
96 ASCII characters	X	X	X	X	X	X
Italics character font		X		X	X	X
Special international symbols				X	X	X
Normal, Emphasized, Double-Strike and Double/Emphasized print modes	X	X	X	X	X	X
Subscript/Superscript print mode				X	X	X
Underline mode				X	X	X
10 CPI	X	X	X	X	X	X
5 CPI	X	X	X	X	X	X
17.16 CPI	X	X	X	X	X	X
8.58 CPI	X	X	X	X	X	X
DOT GRAPHICS MODE						
Line drawing graphics				X	X	X
Bit image 60 D.P.I.		X	X	X	X	X
Bit image 120 D.P.I.		X	X	X	X	X
CONTROL FUNCTIONS						
Software printer reset		X		X	X	X
Adjustable right margin			X	X	X	X
True back space		X		X	X	X
INTERFACES						
Standard — Centronics-style 8-bit parallel	X	X	X	X	X	X
Optional — RS-232C current loop w/2K buffer	X	X	X	X	X	X
RS-232C x-on/x-off w/2K buffer	X	X	X	X	X	X
IEEE-488	X	X	X	X	X	X

*Tandy TRS-80 block graphics only available with GRAFTRAX 80.

ABCDEFGHIJKLMN abcdefghijklmn *ABCDEFGHIJKLMN abcdefghijklmn* 01234
ABCDEFGHIJKLMN abcdefghijklmn *ABCDEFGHIJKLMN abcdefghijklmn* 01234
ABCDEFGHIJKLMN abcdefghijklmn *ABCDEFGHIJKLMN abcdefghijklmn* 01234
ABCDEF abcdef *ABCDEF abcdef* 0123456
ABCDEFGHIJKLMNOPQRSTUVWX abcdefghijklmnopqrstuvwx *ABCDEFGHIJKLMNOPQRSTUVWX abcdefghijklmnopqrstuvwx* 01234567
ABCDEF abcdef *ABCDEF abcdef* 0123456
ABCDEFGHIJKLMN abcdefghijklmn *ABCDEFGHIJKLMN abcdefghijklmn* 01234
ABCDEFGHIJKLMNOPQRSTUVWX abcdefghijklmnopqrstuvwx *ABCDEFGHIJKLMNOPQRSTUVWX abcdefghijklmnopqrstuvwx* 01234567

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User's Column

Terminal Madness, The Word, Grammatik, and Then Some

The critic reviews some new computer terminals, word-processing software, BASIC compilers, and M-drive.

Jerry Pournelle
c/o BYTE Publications
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Hancock, NH 03449

As if we didn't have enough problems here at Chaos Manor, we had to buy a new terminal the other day.

We've had the Godbout 8085/88 running for a couple of months now. (Incidentally, I need a name for that machine; preferably one not too blasphemous.) We set it up with a Zenith Z-19 terminal, which works all right (except that all three that my consultant friend Tony Pietsch bought had a loosely soldered wire in the horizontal amplifier); but I don't like it. The dislike is purely personal: the keyboard is too close to the screen for me. I wear bifocal glasses, and I'm torn between moving my head forward and looking down, or moving back and not being able to see the letters at all.

So, what I wanted was a terminal with detached keyboard. Preferably one with a video output on the back so that I could switch the output onto my big 15-inch Hitachi monitor that sits 29 inches from my head. I also required a really nifty keyboard, one that has a good feel and a Selectric key layout.

I may one day buy an IBM—but not until I get over the shock of that ruined keyboard.

"DEC VT-100," said my engineering-genius friend Tony. "Costs a little more but has everything you want. And DEC equipment is *reliable*. It's also *maintainable*. If I've got to work on it, I prefer DEC."

Only there's no store that sells VT-100s in Los Angeles County, which is weird, but there it is.

"Televideo 950," said Bill Godbout when I asked him. "We're converting to Televideo 950s everywhere, and our people really like them."

That, at least, I could look at, so off I went to Dick Dickenson's establishment, which seems to be named Compu-Plus this week. (It began as Computer Components, where my mad friend and I bought our old memo-wreck keyboards and some other surplus equipment; changed to Computer World; changed again to,

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Dan Mac Lean, RIP

I often start these columns with a quote from my mad friend. Alas, I'll never be able to do that again. Dan Mac Lean died of cancer in December. He'd known for a good year that he had about a year to live.

My mad friend never published much, but he had a great and beneficial effect on the microcomputer world. For one thing, any influence I may have is due to him; he talked me into getting my first machine, held my hand while I learned to use it, and encouraged me to do these columns.

More than that, he was insatiably curious. He examined everything *in the microcomputer field: programs, hardware, and you name it. He'd used it or knew someone who had; and he had strong opinions.*

I suppose he was sometimes wrong, although I can't think of an instance just now; but because he had strong opinions, with good reasons for holding them, he shook up a lot of prejudices. Winning an argument with Mac Lean was possible, but it was never easy; and whether you won or lost, after you discussed a matter with him, you understood it much better than you did when you began.

Mac Lean was an expert software thief: I don't suppose there was a single program in all the world that he hadn't got, somehow. When George Tate first met him, he offered Mac Lean copies of any programs Ashton-Tate had on the grounds that, if he gave them to him, Mac Lean would feel some ethical obligation; and Mac Lean would certainly get them one way or another, anyway.

Understand, my mad friend didn't do *anything unethical with his booty. He never sold anything and was reluctant to give programs away, except to people he knew wouldn't have bought them. But he did analyze programs and try to use them, and his views often got into this column. (At the direction of his widow, all of Mac Lean's disks except those containing his own writings have been reformatted; we'll never know precisely what he had on those disks, which is probably just as well.)*

He also wrote letters. Lord Almighty, did he write letters. Some of them were hilarious. Some were very serious, and many of his suggestions were taken by major firms. He had a lot more influence than you see on the surface.

Mac Lean worked off and on for the U.S. government, as a consultant to private firms, and as a collector of general information. He helped hundreds of people, and we're all going to miss him. I certainly do.

and I kid you not, "The Place You Go To Buy Computers Incorporated"; and now has become Compu-Plus. My son Alex says that next week they'll be Xylophone Computers, but I don't believe that.)

Dickenson had a Televideo 950 set up there, and I played about with it and liked the feel of the keyboard. The screen was rock steady and easy to read. The character set looked good. He had them in stock, and my son Alex needed a terminal for his machine down in San Diego, so if I bought the 950 on the spot, Alex could take my Z-19 away with him.

But there was one other alternative to explore: buy an IBM Personal Computer and teach it to be a terminal. That would be an expensive solution, but just at the moment that's not a problem; so off we went to Computerland, where IBM machines are set up and working.

After all, I've worn out three IBM Selectric typewriters. I know that keyboard and its feel and layout, and I love it. From Gregg Williams's review of the Personal Computer (see "A Closer Look at the IBM Personal Computer," January BYTE 1982, page 36), I could see I would like the graphics and letter set, and IBM sells complete technical manuals for the computer.

Meanwhile, Bill Godbout called to say he was sending me a new Godbout disk controller that would handle Qume DT-5 double-sided double-density 5¼-inch disks in IBM-compatible format. So there was everything going for getting an IBM.

Only IBM has *ruined* the keyboard! What ought to be its strongest point, the thing IBM always excelled at, is its worst mistake.

What IBM did was to put extra keys between the space bar and the Shift key. Why, I don't know. The result is that when you think you've typed, say, a capital T, you get instead /t, which isn't useful at all.

There is also no line-feed key; instead IBM seems to have manipulated the Carriage Return key to give *both* carriage return and line feed when struck. Unfortunately, many programs won't be able to stand that. I suppose there's a way to filter that madness; but there's no help for the Shift key being mislocated, nor for the egregious amount of space between the home keys and the Return key.

I may one day buy an IBM—but not until I get over the shock of that ruined keyboard. I've never been so disappointed in my life.

So back to Dick Dickenson's place for a Televideo, which we took home with us. Installation was no problem. The documents are absolutely clear, the data-rate switches and other such stuff are on the back and clearly marked, and the stop-bit settings are simple enough to understand. Bill Godbout's 8085 BIOS (basic input/output system) is also clear, so I was able to set up the 950 in no time.

At first, the only thing I didn't like about the 950 was minor: the keyboard cable attaches in *back* of the terminal, so that the cord has to come around the side of the machine. It should attach in front.

So we set it up and turned it on, and it worked the first time, controlling the Godbout perfectly. I played about with it a bit, then I loaded Wordmaster.

Blooey.

"Why?" I wondered. So I experimented some more. And sure enough, any time I sent an escape character, the terminal went into a different mode, until eventually it got into a block mode where it didn't send anything to the computer at all.

I looked through the manual. Nothing on that problem. Try logic. The Televideo 950 uses the Escape key to send an escape character out, while Shift-Escape is used to tell the

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machine "This is a setup. Don't send out the next character, but execute it as an internal setup instruction." Unfortunately, this particular machine was broken; Shift-Escape worked fine, but Escape did *both*: that is, it sent out the escape character all right but also executed the next character as an instruction (and sent it out as well). The results were maddening.

So. Back to Compu-Plus. "Take it back," I told Dick. "I want a DEC VT-100."

"Sure you can have your money back," he said. "But I have a Televideo at home, and we've had that one out there as a demo for a year, and nobody ever had any problems with either of them."

It was Saturday, and Alex wanted to go back to San Diego, and he needed a terminal, and they had three more 950s in stock.

"Okay," I said. "I'll take a different one in exchange. Only this time we try it out here."

"Right," said Dick. "We'll plug it in right here where the demo is."

So we did. The first one didn't work: it couldn't set the proper data rate. The next one didn't work. It couldn't set something, I forget what. The third one didn't work. It didn't even turn on. And that was surely enough.

So I've got my money back, and I'm using the Z-19 just now, and I've ordered a DEC VT-100. You can conclude anything you want from my ordeal. One lesson for sure is that, although Dick Dickenson's price for a Televideo 950 is about $150 above the discount houses, he was right there and ready to take care of it for me when I had a problem. It's worth dealing with established firms with a reputation for good service; or so say I.

Words

I have here the biggest software bargain I know. It's called The Word, and it comes from Oasis Systems.

The Word is a spelling program; but it's also a *lot* more. It counts words for you. It makes files of words. It will make a list of each unique word in a text file and sort it alphabetically. It will also do a list of each word used and the number of times you used it, sorted by frequency of use.

I've used The Word to find strange character names: that is, I'm working on *Janissaries Two* right now. That story takes place on a planet settled by successive waves of Celts, Minoans, Romans, and Franks, so that the character names tend to be a little strange. They have to be kept consistent with the culture in which they appear.

This is all right for major characters, but what if I'm writing along and need a minor character name? I grab one of my reference works (such as Robert Graves's *Greek Myths* or R. W. Munro's *Highland Clans and Tartans*) and find a suitable name in the index; and if I'm sensible, I make a note of that somewhere. But usually I don't make the note or can't find it, and I can't remember where this particular spear carrier appeared when I need to use him (her, it) again.

But with The Word, I can simply run the text through the spelling program, and the program makes a file of all the words it doesn't recognize. I can now examine that file, and, lo!, there will be my strange character name.

Then with the Find program I got from Barry Workman (Utility Disk One) I can go right into the text files and find that word in context. Saves no end of time.

The Word does much more; and it sells for under $100, which is why I say it's the biggest bargain in word-handling software I know.

Incidentally, I'm still using Spellguard too. The Word, while excellent, isn't quite as convenient for the straight job of checking spelling, particularly at three in the morning when I don't want to think about options and toggles and command lines. I want a fully menu-driven program that just does what I ask it to without quibbles; and that's Spellguard. But for really sophisticated word work fully under user control, you just won't beat The Word. [**Editor's Note:** *Oasis Systems has just announced The Word Plus. Priced at $150, several features have been added including display of suspect words in context, the ability to use LOOKUP from within REVIEW, and the ability*

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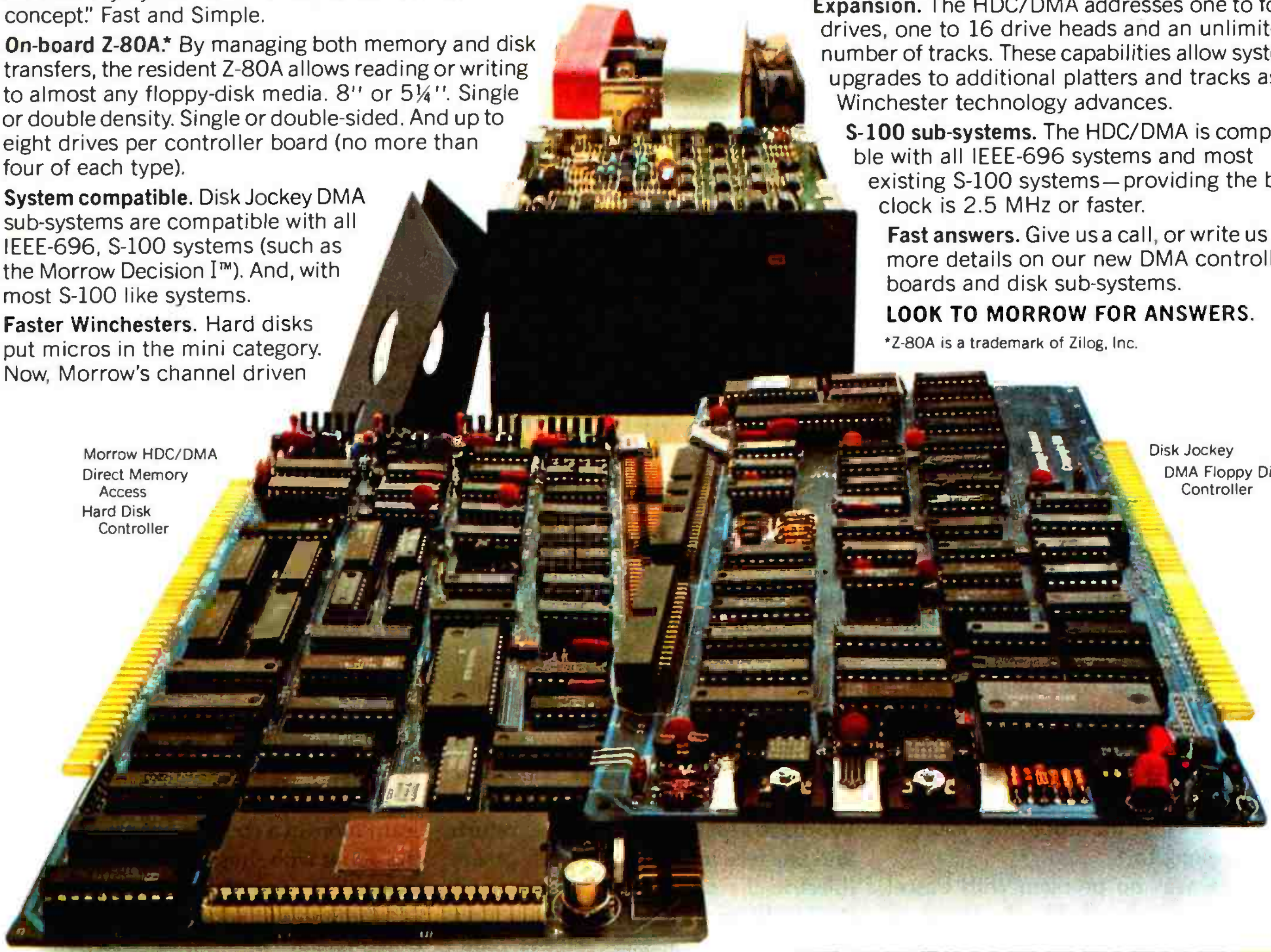

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Photo 1: *The critic at work at his California home. Photo by Frank Pournelle.*

to have the software actually make the correction in your text file. Present owners of The Word will be able to upgrade to Plus for the difference in cost between the two packages. The original version of The Word will still be available for $75. . . . **M.H.**]

Pascal, Anyone?

My son Alex is a senior in computer science at the University of California, San Diego. Since they developed UCSD Pascal there, you will understand that he's become fairly proficient in it.

When we got the Godbout 8085/88 running here, Alex undertook to write some utilities for me, using Sorcim's Pascal-M on the new Godbout machine. Consequently, I had the fascinating experience of watching someone familiar with computers and Pascal, but unfamiliar with CP/M, trying to get programs running. So, as it happens, did Barry Workman, who happened to be over. (He's an assistant scoutmaster in the troop my younger boys belong to.)

There was no problem with Pascal itself. The Sorcim documentation is adequate for that, provided that you're fairly familiar with Pascal.

Hooking to CP/M was another story. Of course Pascal is notoriously deficient in input-output (I/O) to begin with, and it's not so hot in handling strings. But the Sorcim Pascal has a "feature" that sometimes makes things even worse. When Sorcim Pascal looks at a file using the "read line" Pascal command, *it ignores line feeds*.

A story goes with that. The American Standard Code for Information Interchange (ASCII), while nice enough to work with in many respects, has one defect: there's no new-line character. Instead, there are carriage return and line feed, two separate characters which together give you a new line. Many programs will insert a line feed when they see a carriage return. Others will not. All have to deal with this somehow. Sorcim Pascal-M solves the problem by ignoring line feeds altogether.

Now this is a good thing under certain circumstances because some text editors (for example, Wordmaster and Wordstar) put both carriage return and line feed into the text, while others (Electric Pencil, Magic Wand, and WRITE [Writer's Really Incredible Text Editor]) insert carriage returns only. (To make the confusion complete, Electric Pencil and WRITE mark the ends of paragraphs when you hit the Line Feed key; but the mark they actually insert in the text is not a line feed, but a carriage return!) In any event, what appear to be identical files can be different, depending on the editor that created them. What is the poor Pascal programmer to do? So the Sorcim solution is as good as any, except. . . .

Unfortunately, Sorcim has not provided a way to turn this feature off; so that if you want to make an exact copy of a file, you must go through massive contortions to test for whether or not there were line feeds in the original file.

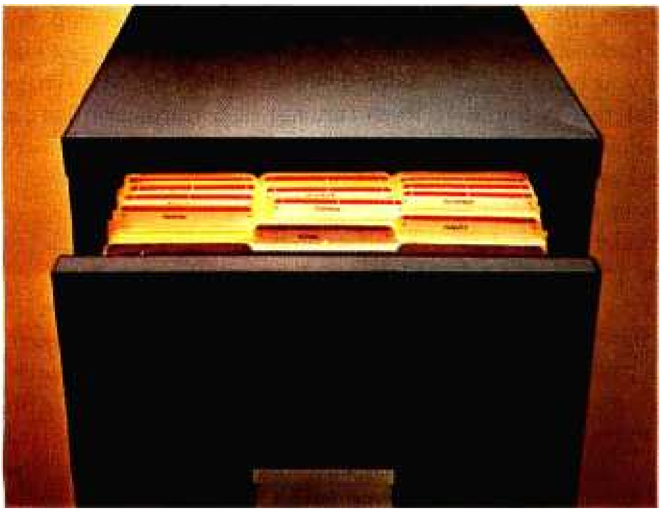
Now the way I intended to learn Pascal was to go through the excellent book *Software Tools in Pascal* by Kernighan and Plauger (Addison-Wesley, 1981) and implement all their utilities as I came to them. Alas, one of the first utilities was a Copy utility, and what could I do about the line-feed and carriage-return problem? Worse, none of that is explained in either Kernighan and Plauger or the Pascal-M documentation. (The documentation tells you that the read-line utility ignores line feeds but doesn't tell you the consequences and the way to get around the problem if you want to see if there were line feeds.)

Eventually Alex managed a way around the problem, and after that he turned out programs in rapid fire order. He'll shortly have written a really good text formatter and printer that will do everything but wash the dishes; the basic program and most of its features work now.

He also got many of the programs from Kernighan and Plauger running and, for good measure, set up some of the demonstration programs for me from Peter Grogono's really excellent *Programming in Pascal* (Addison-Wesley, 1980) so that they work with CP/M. The result is that now I can use Kernighan and Plauger, and Grogono as tutorial guides to learning the Pascal language.

And the books are really good. I can learn more in a couple of hours of playing about with those books and getting the programs up than I can in a week of reading; and when I'm through, I often have useful utilities as well.

At this point enter Barry Workman.



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"That's worth something," he said. "There's lots of people who want to learn Pascal and get discouraged because they don't know where to start. You take those programs Alex did, his notes, your notes, and the two books, and you've got a complete guide to learning the language."

"Not me," said I. "I write books for a living, articles for fun, and programs for a hobby, and I'm damned if I'll get into the software publishing business."

"But I'm in the software publishing business," said Barry. "At least by default." (His normal business is consulting on new installations, but he's slowly built up the mail-order publishing end as a sideline.) "Let me put that out for you."

So, Workman offers a package deal on learning Pascal. The disk with Alex's programs (sources and notes) and my notes on what I thought I needed to know is $50, and whether or not it's worth it depends entirely on how badly you want to learn Pascal and how much of a duffer you are when you begin work. I can truthfully say I wish I'd had the package when I started; it would have saved me a week and perhaps more. But it is not the Earth. You'll still need to work.

Understand that you will also need Grogono's *Programming in Pascal* and Kernighan and Plauger's *Software Tools in Pascal*. Each sells for about $15.95 in book stores and computer shops. Workman will send the two of them postpaid for $20 each, so that his total package is $90 if you want it all.

And understand that this is implemented for Sorcim's Pascal-M. Since Alex's programs are in Pascal, you will *not be able to run them* if you don't have the Sorcim compiler. (Alex has done exactly the same job on Digital Research's Pascal-MT+. See Items Reviewed, page 298.) Barry Workman has now put together a package that includes Pascal-M (or Pascal-MT+), Alex's programs and notes, my notes, and the two books.

Alex's evaluation of the two Pascals is that both are very good. If you're doing a lot of experimental programming, you'll want the Sorcim Pascal—which is also the best one to learn the language on. This is because Sorcim's Pascal-M compiles like lightning, much faster than UCSD Pascal or MT+ will compile. The error messages are very complete and informative. Thus you can do a lot of programming work in a short time.

Pascal-M's shortcoming is that it compiles to an intermediate code, and thus the programs written in Pascal-M tend to be slow. Not egregiously slow, but certainly slower than programs written in Pascal-MT+, which compiles to machine language. So if you're more interested in your programs running fast, you'll want Digital Research's MT+.

Me, I keep both and develop programs with the Sorcim package. Then when they're running I use MT+ to get them running fast; translation isn't all that difficult. But that's an expensive solution.

The Great BASIC Compiler Debate

I recently received several letters imploring me to choose between Microsoft's BASCOM and Digital Research's CB-80. Both are, of course, BASIC compilers; the difference is that BASCOM compiles Microsoft's *interpretive* BASIC, while CB-80 compiles CBASIC, which is itself a pseudocompiled language.

Unfortunately, those were no easy letters to answer. As usual, the answer is "it depends."

First, let's establish something: of the two languages, CB-80 is unquestionably better if your criteria are ease of use and ability to write structured programs. CB-80 has "functions" that are indistinguishable in operation from Pascal procedures and calls by label (GOSUB DO-ONE is a perfectly legal statement). CB-80 has a whole host of features that Microsoft's BASIC simply doesn't support.

Why, then, don't I simply recommend CB-80 and be done with it?

It's a bit like Pascal-M vs. Pascal-MT+. Microsoft's BASCOM, used in conjunction with Microsoft's inter-

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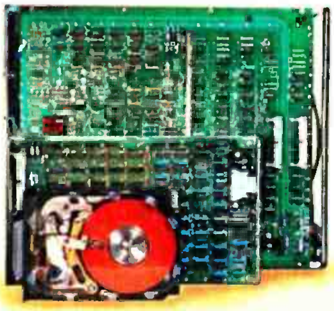

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pretive BASIC, isn't as fast or as convenient as CB-80; but you can get your program running much more easily because of the *interpretive* feature of the language. With Microsoft's BASIC you can write a complex program and run it (slowly) in the interpretive mode. You'll be able immediately to correct all the syntax errors and other trivia, after which you can check the program logic to see that the damned thing really does what you wanted it to do. Only then must you invest the time in actual compilation.

With CB-80, you must write the program; compile it, at which time you'll undoubtedly find a dozen trivial errors; put it back in your editor and fix the trivia; compile again, when you'll find more trivial errors that were masked by the first set of errors; etc. After about four to five iterations of the above, you'll finally be ready to check program logic, which may also drive you crazy because you can't jump around in the program at will the way you can in an interpretive language.

So, what do you want? As for me, I find I do the following: for a quick and dirty program, one I want to get running *right now*, I invariably use Microsoft's BASIC; if I'm going to use it very much, I then compile it with BASCOM.

For a program that will be part of my permanent inventory, meaning that it's complex and will need modifications over the years, and for which I'll want lots of comments and a rigid structure, I almost always start with CB-80. That's because CB-80 programs are inherently better structured than BASCOM programs.

Sometimes I'll use Microsoft's BASIC to get started, then translate to CB-80 later; but that's rare because CB-80 has so many nifty features that Microsoft's BASIC lacks.

But that's me. I discussed this with my mad friend not long before he died, and he said—not unsurprisingly—that the answer is "none of the above." Mac Lean was enamored of Digital Research's PL-I/80, which is admittedly harder to learn than either of the above BASICs, but which he claimed was far more powerful than either.

And my son Alex, not surprisingly, argues that Pascal is much better; a sentiment shared by Carl Helmers, the former editorial director of this magazine.

And if all that's not enough, I can find no end of people to tell you that you must ignore *all* of the above and adopt the C programming language. The latter is a view for which I have surprisingly friendly sentiment; but the problem is that there is no good C compiler for microcomputer systems. Now true, Leor Zolman's BDS C (B.D. Software C, available from Lifeboat Associates, and worth the price even if you're only mildly curious about C) is a truly amazing product; but it isn't the full C language, and the omissions are not trivial. The Whitesmiths C compiler is a full C compiler (provided you have more than 60K bytes of free memory), but it is slower than molasses in January and has perhaps the worst error-reporting features of any language I've ever seen. You can spend *days* trying to get the simplest program running in Whitesmiths C.

And yet, the C language compiles to the tightest code of all the higher-level languages. It runs fast and is suitable for operating-system programming—something you certainly can't say for any of the other higher-level languages. If there were a really decent C for microcomputers I'd be inclined to support it; and I'm very much looking forward to the development of a good C for my Godbout 8088.

As of this writing, I've no definitive advice. If I could buy only one higher-level language, I suppose I'd get CB-80, an opinion which I suspect is causing my mad friend to revolve rapidly because he didn't care much for BASIC in any of its guises. The second one I'd buy would be BDS C, followed by BASCOM, and PL/I-80. But that's me, and I've different problems from many of you.

I wish I could be more definitive.

Goodies

One reason you'll probably want the BDS C compiler is the BDS C User's Group. It puts out a truly amazing pile of useful software at practically no cost. You can purchase file comparators, Game of Life, graphics for the Z-19 terminal, Pong games, Rally games, and the like. If you like playing with computers, you really ought to have BDS C and belong to the user group; if you get something you like only once a year, that's worth the cost.

I'm also pleased to say that WRITE, devised for Larry Niven and myself by Anton Pietsch, is now available from Ashton-Tate for *terminals* as well as for memory-mapped video. I'm using it on the Z-19 right now, and it has a mind-staggering pile of features that really work. George Tate tells me that by the time you read this it will have been announced and demonstrated at the West Coast Computer Faire.

WRITE will, in my judgment, blow Wordstar out of the market. I know that's a heavy statement, given the number of people using Wordstar; but I still think it's true. WRITE is a truly transparent editor. To use it, you just type. If you want to go back and insert and delete and in general mess about with your text, WRITE reformats the paragraphs automatically; there aren't any danglers poking out at the end as if your sentences had rigor mortis. WRITE lets you change disks while your text is in the machine, so that paranoids (like me) can make safety copies that are truly safe. (The worst power failure isn't going to go across the room to the bookcase to clobber my disk.)

And so forth. Obviously I'm prejudiced. Not that I get any profit from WRITE, because I don't; but the program was written to make Larry Niven and me happy. All I can say is, get a demonstration; if you're a creative writer, I can't believe you won't prefer WRITE to any other text editor you've seen. Meanwhile, Tony is also doing a programmer's version of WRITE that, he says, will more than compete with Wordmaster.

Grammar, Anyone?

One real problem with artificial intelligence is that we can teach computers to spell, but we can't really teach them grammar. For all the rules that appear to be rigid, when you get right inside the grammar of English, there is far too much of the "you-know-what-I-mean" type of statement.

One valiant attempt to change this comes from the Aspen Software Company, which makes Proofreader and

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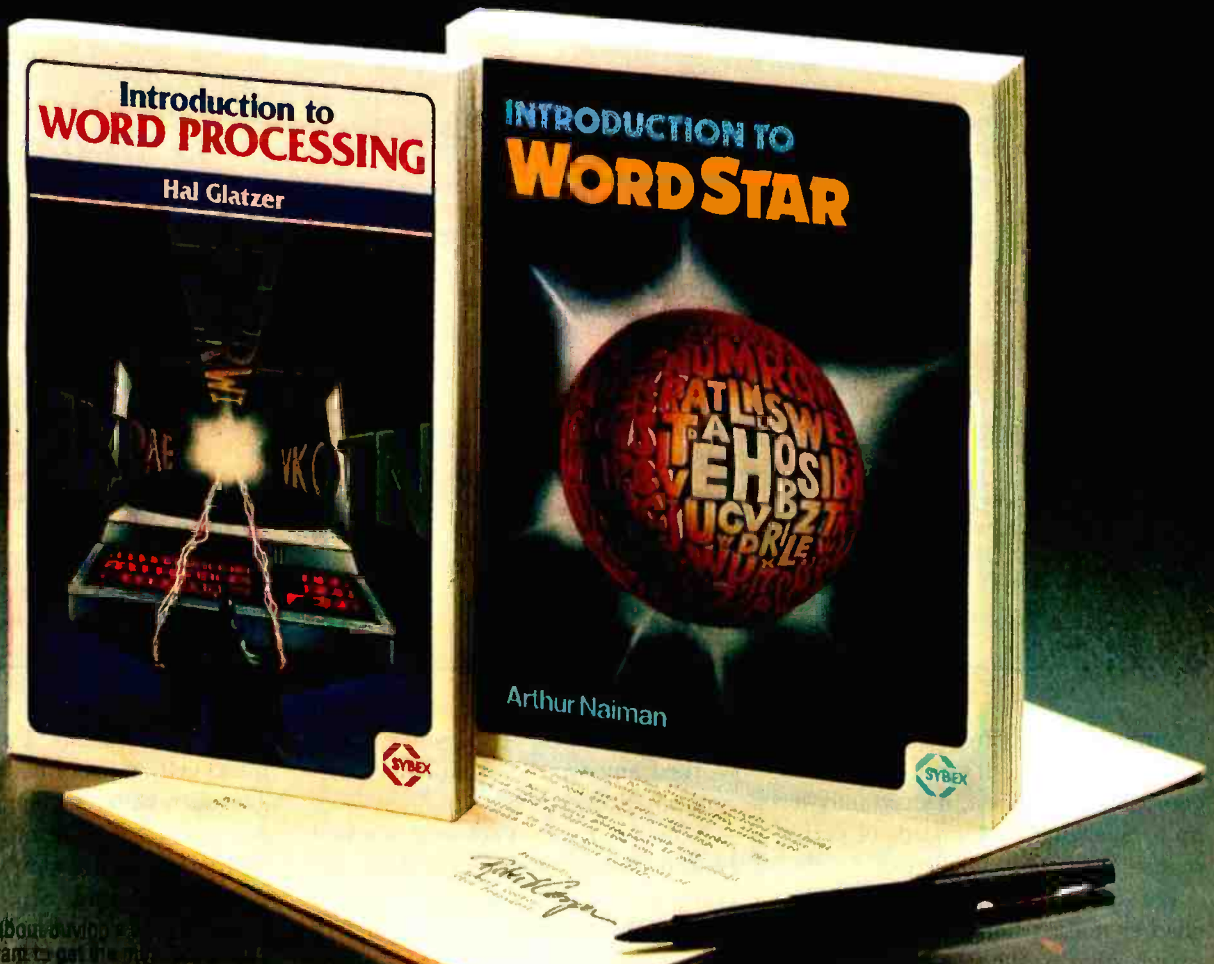

If you're thinking about buying a [illegible] cessor, or if you want to get the [illegible] system you have, these two SYBEX [illegible] required reading.

Introduction to Word Processing by Hal Glatzer, $12.95, contains over 200 pages of easy-to-understand information on what a word processor can do for you, how to evaluate what kind of system best fits your needs, and a step-by-step guide on how to use a word processor.

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Introduction to WordStar™ by Arthur Naiman, $8.95. Learn how easy it is to use WordStar, today's most popular and powerful word processing program. Get off to a smooth start with this clear, complete reference manual which teaches you the program, step-by-step. You'll learn how to: • edit copy • move and delete blocks of text • create and merge files • check copy for spelling accuracy • format on-screen • create special print effects • and more! Graphically designed for the convenience of the reader, *Introduction to WordStar™* is a finger-tip guide and indispensable reference for both beginners and experienced users.

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Items Reviewed

Ashton-Tate
9929 Jefferson
Los Angeles, CA 90230

WRITE (Writers' Really Incredible Text Editor for terminals)	$395

Aspen Software Company
POB 339
Tijeras, NM 87059

Proofreader and Grammatik (combined)	
IBM Personal Computer	$250
TRS-80 Model I or III	$139
TRS-80 Model II	$179

CompuPro/Godbout
Oakland Airport, CA 94614

M-Drive	
128K memory	$1590
256K memory	$3100

Digital Research
POB 579
Pacific Grove, CA 93950

Pascal-MT + 5.5 system	$350
CB-80 1.1	$500

IBM
Information Systems Division
Entry Systems Business
POB 1328
Boca Raton, FL 33432

IBM Personal Computer	$1600

Lifeboat Associates
1651 Third Ave.
New York, NY 10028

BDS C Compiler	$150

Microsoft
400 108th Ave. NE
Suite 200
Bellevue, WA 98004

BASCOM BASIC Compiler CP/M and Apple	$395

Oasis Systems
2765 Reynard Way
San Diego, CA 92103

The Word	$75

Osborne Computer Corporation
26500 Corporate Ave.
Hayward, CA 94545

Osborne 1	$1795

Sorcim Corporation
405 Aldo Ave.
Santa Clara, CA 95050

Pascal-M	$395

Televideo Systems Inc.
1170 Morse Ave.
Sunnyvale, CA 94086

Televideo 950	$1195

Whitesmiths Ltd.
POB 1132
Ansonia Station
New York, NY 10023

C compiler for CP/M	$750

Workman & Associates
112 Marion Ave.
Pasadena, CA 91106

Utility Disk One (including FIND)	$32.50
Pascal Primer	$50
with Grogono's *Programming in Pascal* and Kernighan and Plauger's *Software Tools in Pascal*	$90
with both books and Sorcim's Pascal-M compiler	$350
with both books and Digital Research's Pascal-MT + compiler	$425

Books Reviewed

Software Tools in Pascal by Brian W. Kernighan and P. J. Plauger, Reading, MA: Addison-Wesley Publishing Company, 1981.	$15.95
Programming in Pascal by Peter Grogono, Reading, MA: Addison-Wesley Publishing Company, 1980	$15.95

Grammatik. Proofreader is another spelling program. It's not very good, compared to the best; it's certainly not up to Spellguard's standards of performance as far as convenience.

For one thing, the Aspen spelling checker doesn't know about dot commands: that is, whereas the best spelling programs know that a line beginning with a period is a command line and contains words to be ignored, Proofreader faithfully offers all my formatting commands as candidate misspelled words. It's also quite slow, even on the 8085 at 6 MHz.

What makes the Aspen program unique is Grammatik, which is an attempt to teach a computer elementary rules of grammar. Grammatik is an integral part of Proofreader and is invoked from within that program. It first makes a table of words by frequency (just as The Word does); the idea here is to let you see if you've overworked any words. Then it looks for "grammatical errors."

Now, no program yet written actually understands English grammar; certainly none that work on 8-bit microcomputers can. Grammatik can look for strange errors, such as doubled words ("the the") and STicky SHift KEy (more than one letter capitalized in a word). It makes sure that the first letter of each sentence (defined as the word following a period; be wary of abbreviations) is capitalized. It can find misplaced or unbalanced quotation marks, and it can look at a table of trite and overworked phrases that are best avoided and indicate them on the screen. In other words, it's useful if your work has to do with words. I've been using it since it arrived with no regrets.

Proofreader is apparently available without Grammatik; I wouldn't recommend getting Proofreader alone. There are much better spelling programs. I'm not sure that Grammatik will work without Proofreader, which compromises its value. So it goes.

Integrity and High Speed

We now have four major computers: Ezekial, my five-year-old Cromemco Z-2 Z80; the Osborne; the Godbout 8085/88; and Alex's CCS (California Computer Systems) Z80. There's also Dr. Stefan Possony's CCS in Palo Alto, California, and we have a cousinly relationship with the L-5 Society, which has installed a Godbout.

Amazingly, we're happy with all of them. The Osborne, just at the moment, is in the shop; we got one of the really early ones made before they shook the bugs out of it. The dealer to whom Alex took it doesn't know that I

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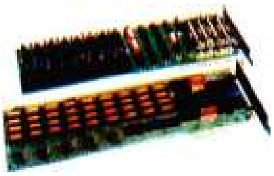

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got mine direct from Adam Osborne or that I'm going to write a review. As far as he's concerned he's got an early model, well past its warranty date, but with an early main board known to be defective. *And* he's having it fixed. There is, it seems, a directive from Osborne headquarters covering such cases. Consequently, they're installing completely new electronics, at no cost. And, I hasten to add, the Osborne you can buy now comes already with the newly designed board.

So, where does this put Osborne? As one of those companies that uses its customers as its quality-control department? No. There is, after all, one company around with a prodigious reputation for delivering DOA equipment (that is, equipment dead on arrival) and doing nothing at all about the problems. It hasn't redesigned anything, nor has it made contact with all its dealers to tell them how to handle the problems. It just goes on buying advertising.

Osborne, on the other hand, obviously wants to make his customers happy. He keeps sending software updates, for example; and when he finds a design defect in his early models, he eats the cost of updating them. So, sure, it would have been better if there hadn't been problems with the first three hundred machines delivered; but that was, after all, a fairly small number, and Lord knows Adam Osborne has worked prodigiously to rectify any early problems.

And until the flaw showed up, as mentioned above, the Osborne performed more than satisfactorily. We've amazed a lot of friends with it. And we've now got it talking to our other machines, so that we can put programs in it and get text out. I use it at all my meetings and conferences, and I've missed it the past few days that it was gone.

Then there's the Godbout 8085/88: built like a Mack truck and every bit as reliable; the only thing to report about its operations is that there's nothing to report.

We do have a new feature, though. We've just installed Bill Godbout's M-Drive, which is a way of fooling your computer programs into thinking that a lot of extra memory (in our case 512K) is a disk drive; and you can't believe how fast that runs. Compilations and assemblies are nearly instantaneous. Of course the data isn't saved that way; if the power goes off, you've lost it. But for compilations and the like, who cares? Compile once with M-Drive, and if it compiles without errors, save it on disk. If there are errors, you get the result instantly and can fix things.

I wouldn't recommend M-drive for people primarily concerned with text and creative writing because they'll mostly be concerned with preservation of their output. I, for instance, want to see a copy of my text disks in a box on the other side of the room before I'm completely satisfied. But for programmers with frequent test compilations and the like, the Godbout M-Drive is a real godsend. ■

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The Atari Tutorial

Part 10: Human Engineering

The interaction between the computer and its human user is easily the most important—and most often neglected—aspect of commercial software.

Chris Crawford
Atari Inc.
1265 Borregas Ave.
POB 427
Sunnyvale, CA 94086

The Atari home computer is first and foremost a consumer computer, being designed to make it easy for people to use. Many of the hardware features protect the consumer from inadvertent errors. Because the average consumer is unfamiliar with the conventions and traditions of the computer world, software should reflect an equal concern for the consumer. If a program is understandable, it will be used correctly most of the time. Occasionally, a user will be careless and make mistakes. It is the programmer's responsibility to protect the user from as many mistakes as possible.

Human engineering refers to the interaction between the design of tools and the resulting ease of use by people. The current state of human engineering found in personal computer software is dismal. Many programs being sold contain atrocious design decisions that reflect unawareness of human engineering. Although the worst offenders are written by amateur programmers, even software written at some of the largest firms shows occasional lapses in this respect.

Can you imagine what Star Raiders would be like without animation?

Human engineering is an art, not a science. It demands great technical skill, but it also requires insight and sensitivity. As such, it is a highly subjective field devoid of absolutes. Since this article is the work of one hand, it betrays the subjectivity of its author. A full treatment of the many opinions on the subject would be both lengthy and confusing. I therefore chose the simpler and more pleasant task of presenting only my own point of view, giving appropriate lip service to the most serious objections. The result is contradictory enough to satisfy even the most academic of readers.

The Computer as a Sentient Being

An instructive way of viewing the problem of human engineering is to cast the programmer as a sorcerer who conjures up an intelligent being, a *homunculus,* within the innards of the computer. This creature lacks physical embodiment but possesses intellectual traits—specifically, the ability to process and organize information. Although the user of the program enters into a relationship with this homunculus, these two sentient beings think differently. The human's thought patterns are associative, integrative, and diffuse; the program's thought processes are direct, analytical, and specific. These differences *are* complementary and productive because the homunculus does well what the human cannot. Unfortunately, these differences also create a communications barrier between the user and the homunculus. They have much to say to each other because they are so different, but because they are different they cannot communicate well.

The central aim of good programming should therefore be to provide better communications between the user and the homunculus. Sad to say,

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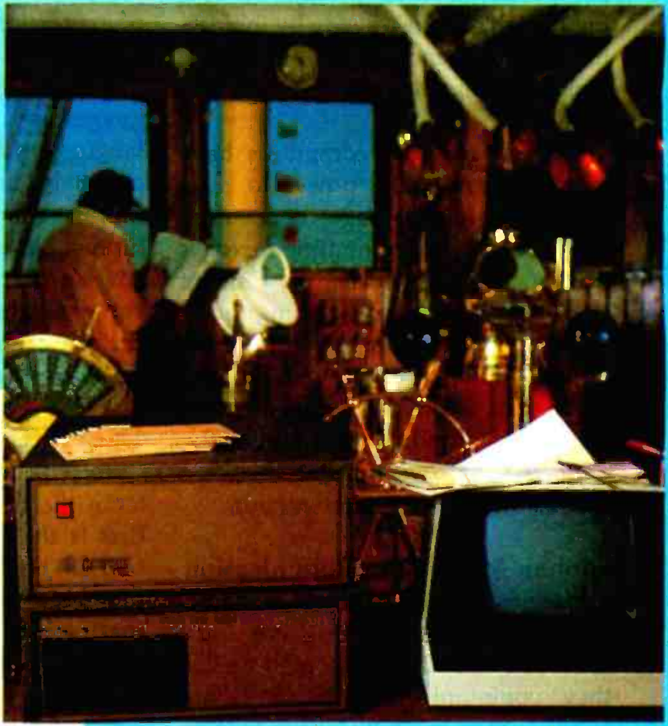

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many programmers expend the greater part of their efforts on expanding and improving the processing power of their programs. This *only* heightens the tragedy by increasing the *intelligence* of the homunculus while leaving him blind, deaf, and dumb.

Today's personal computers have sufficient computing power to meet many of the average consumer's needs. The primary limiting factor is no longer clock speed or resident memory; the primary limiting factor is now the thin pipeline connecting our now-intelligent homunculus with his human user. Each can process information rapidly and efficiently; only the narrow pipeline between them slows down the interaction.

Human-Machine Communication

How can we widen the pipeline between the two thinkers? We must focus on the language with which they communicate. Like any language, a man-machine language is restricted by the physical means of expression available to the speakers. Because the computer and the human are physically different, their modes of expression are physically different. This forces us to create a language that is not symmetric (as human languages are). Instead, a man-machine language will have two very different channels: an input channel and an output channel. Just as we study human language by first studying the sounds that the human vocal tract can generate, we begin by examining the physical components of the man-machine interface.

Output (Computer to Human)

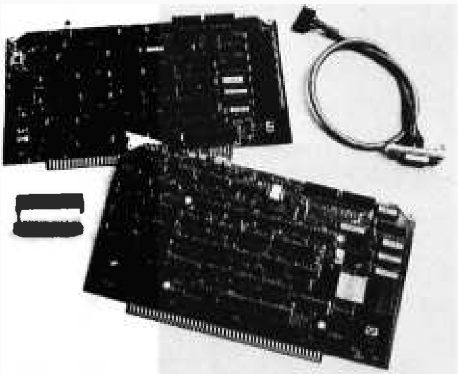
Two primary output channels go from the computer to the user. The first is the television screen; the second is the television speaker. Fortunately, these are flexible devices that permit a broad range of expression. For the purposes of this article, it is better to discuss these devices in terms of the human point of view. Of the two devices (screen and speaker), the display screen is easily the more expressive and powerful device. The human eye is a more finely developed device for gathering information than the human ear. An electrical engineer might say that the eye has more "bandwidth" than the ear—that is, it can interpret a far more complex input stream. The eye can process three major forms of visual information: shapes, color, and animation.

Shapes

Shapes are an ideal means for presenting information to the human eye. The human retina is especially adept at recognizing shapes. The most direct use of shapes is for the depiction of objects. If you want the program to tell the user about something, draw a picture of it. A picture is direct and immediately recognizable.

The second use of shapes is for symbols. Some concepts in the human lexicon defy direct depiction. Concepts like love, infinity, and direction cannot be shown with pictures. They must instead be conveyed with symbols, such as a heart, a horizontal figure 8, or an arrow. These are a few of the many symbols we all recognize and use. Sometimes you can create an ad hoc symbol for limited use in your program. Most people can adapt to such a symbol quite readily. Although symbols are a compact way to express an idea, they should not be used in place of pictures unless compactness is essential. A symbol is an indirect expression; a picture is a direct expression. The picture conveys the idea more directly and more forcefully.

The third and most common use of shapes is for text. A letter is an indirect symbol; we put letters together to form words. The language thereby produced is extremely rich in its expressive power. Truly it is said, "If you can't say it, you don't know it." This expressive power is gained at the price of extreme indirection. The word that expresses an idea has no sensory or emotional connection whatever with the idea itself. We are forced to carry out extensive mental



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gymnastics to decipher the word. Of course, we do it so often that we have become quite fluent at translating strings of letters into ideas. We do not notice the effort. The important point is that the indirection detracts from the immediacy and forcefulness of the communication.

One school of thought maintains that text is superior to graphics for communication purposes. The gist of the argument is that text encourages freer use of the reader's rich imagination, while graphic depiction of reality always falls short of our imaginative expectations. This argument fails to convince me because it seems to arbitrarily draw a line between the user's need for information and the ability to supply information through the use of imagination. If the user has an active imagination, why is the program needed at all? Why doesn't the user simply imagine the entire program? Conversely, if a small amount of information provided in the form of text is the seed for the user's imagination, would not more information, provided in the form of graphics images, encourage even grander flights of imaginative fancy? An equal exercise of imagination with graphics should provide even greater results.

The eye can process three major forms of visual information: shapes, color, and animation.

A more compelling argument for text is that its indirection allows it to pack a considerable amount of information into a small space. The space constraints on any real communication make text's greater compactness valuable. Nevertheless, this does not make text superior to graphics; it simply makes text more economical. Graphics requires more space, time, memory, or money, but it also communicates better than text. To some extent, the choice between graphics and text is a matter of taste, and the taste of the buying public has never been in doubt. Compare the popularity of television with that of radio, or the popularity of movies with books. Graphics beats text easily.

Color

Color is another vehicle for conveying information. Since it is less powerful than shape, it normally plays a secondary role in visual presentations. Its most *frequent* use is to differentiate between otherwise indistinguishable shapes. It also plays an important role in providing cues to the user. Good color can salvage an otherwise ambiguous shape. For example, a tree represented as a character must fit inside an 8- by 8-pixel grid. The grid is too small to draw a recognizable tree. By coloring the tree green, however, the image becomes much easier to recognize. Color is also useful for attracting attention or signaling important

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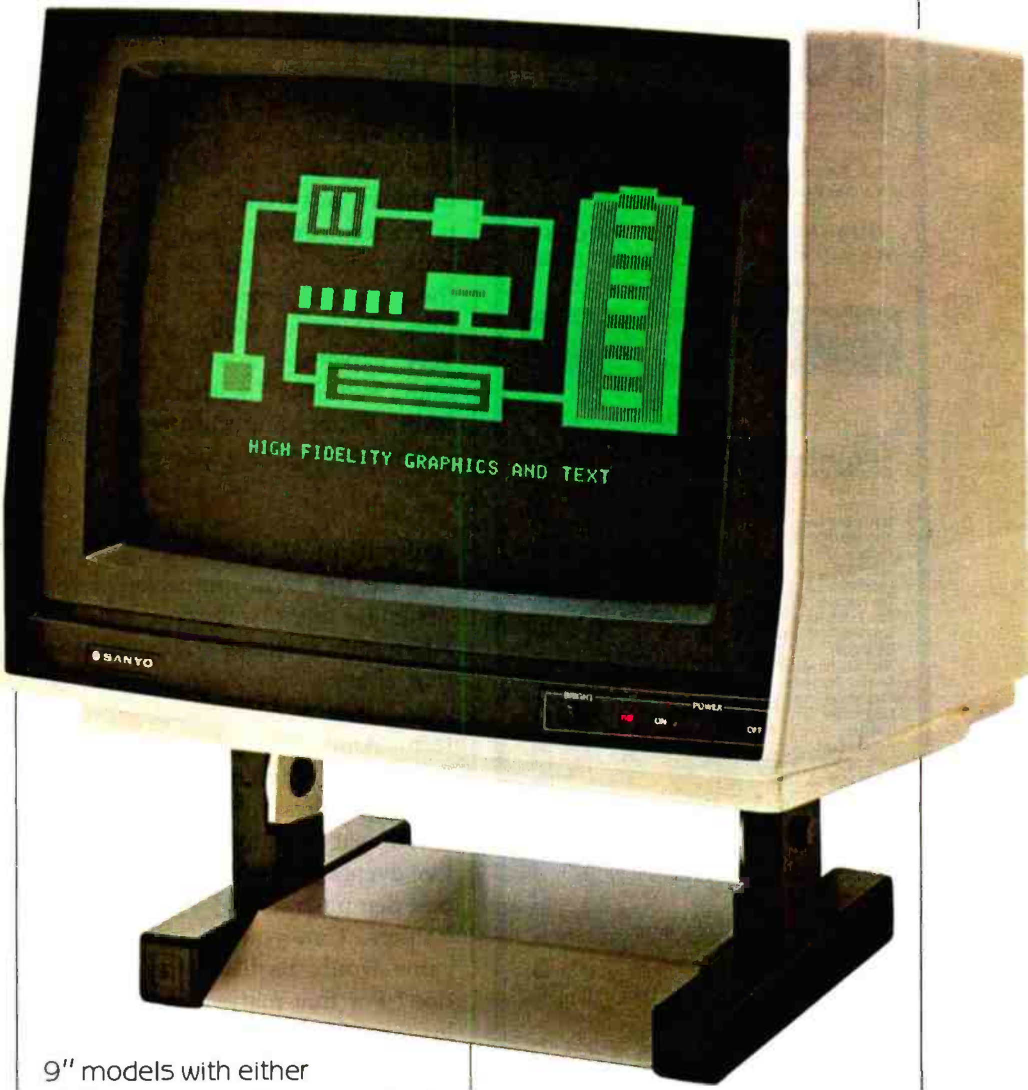

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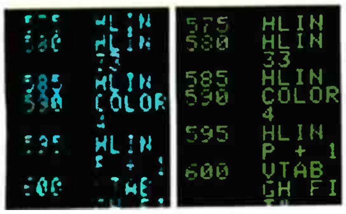

Compare display quality of a typical home TV (left) with a Sanyo professional monitor (right).

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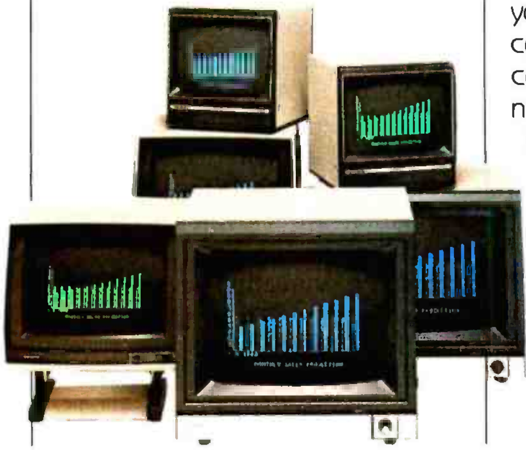

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material. Hot colors attract attention. Finally, use of color enhances the aesthetic appeal of any program. Colored images are more pleasing to look at than black-and-white images.

Hard-boiled programmers may question the relevance of aesthetic considerations to communications. The obvious attention to the design of highway advertising billboards and television commercials indicates the importance our culture attaches to the aesthetic aspect of communication. These carefully planned and very expensive ads are little more than exquisite aesthetic trappings (skin, glitter, and chrome) wrapped around a corporate logo.

Animation

I use the term *animation* here to designate any change in the display. Animation includes colors or shapes that change, moving foreground objects, or a moving background pattern. Animation's primary value is for showing dynamic processes. Indeed, graphics animation is the only way to successfully present highly active events. The value of animation is best demonstrated by a game like Star Raiders. Can you imagine what the game would be like without animation? For that matter, can you imagine what it would be like in pure text?

The value of animation extends far beyond games. Animation allows the designer to show dynamic, changing events clearly. The ability to do animation is one of the major advantages that computers have over paper-and-ink as an information technology. Animation is very powerful in sensory terms. The human eye is organized to respond strongly to changes in the visual field. Animation attracts the eye's attention.

Finally, animation increases the energy level of the program, consequently increasing the user's emotional involvement. Many program failures are due to user failures, which in turn can be traced to user inattentiveness. If you want the user's attention, you've got to jump up and down.

Sound

Graphics images must be looked at to have effect. Sound can reach a user's ears even when the user is not paying direct attention to the video display. Sound therefore has great value as an annunciator or warning cue. A wide variety of beeps, tones, and grunts can be used to signal feedback to the user. Correct actions can be answered with a pleasant bell tone. Warning conditions can be noted with a honk.

Sound has a second use: providing realistic sound effects. Quality sound effects greatly add to the impact of a program because the sound provides a second channel of information flow that is effective even when the user is overlooking the visual component of the program.

Sound is ill-suited for conveying straight factual information; most people do not have the aural acuity to distinguish fine tone differences. Sound is much more effective for conveying emotional states or responses. People associate many sounds with emotional states. A descending sequence of notes implies deteriorating circumstances. An explosive sound denotes destruction. A fanfare announces an important arrival. Certain note sequences from widely recognized popular songs are immediately associated with particular feelings. For example, in Energy Czar, a dirge indicates that the user's energy mismanagement has ruined America's energy situation; a fragment of "Happy Days Are Here Again" indicates success.

Input (Human to Computer)

Three input devices are most commonly used with the Atari 400/800 home computer: the keyboard, paddles, and joystick.

The keyboard is easily the most powerful input device available to the designer, with more than 50 direct keystrokes immediately available. Use of the Control and Shift keys more than doubles the number of distinguishable entries possible. The Caps/Lowr and Atari keys extend the expressive range of the keyboard

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even further. Thus, with a single keystroke, the user can designate one of 125 commands. A pair of keystrokes can address more than 15,000 selections. Obviously, this device is very expressive; it can easily handle the communications needs of any program. For this reason, the keyboard is the input device of choice among programmers.

While the strengths of the keyboard are undeniable, its weaknesses are seldom recognized. Its first weakness is that few people know how to use it well. Programmers use keyboards heavily in their daily work; consequently, they are fast typists. The average consumer, however, is not too comfortable with a keyboard, which can lead to many wrong keys being pressed. The very existence of all those keys, and the knowledge that one must press the correct key, is itself intimidating to many people.

A second weakness of the keyboard is its indirection. It is very difficult to attach direct meaning to a keyboard because it has no obvious emotional or sensory significance. The new user has great difficulty relating to it. All work with the keyboard is symbolic, using buttons marked with symbols that are assigned meaning by the circumstances. The nested indirection of this can be most confusing to the beginner. Keyboards also suffer from their natural association with text displays; I have already discussed the weaknesses of text as a medium for information transfer.

Another property of the keyboard that the designer must keep in mind is its digital nature. The keyboard is digital both in selection and in time (i.e., keyboard input is divided into keystrokes, and only one keystroke can be entered at a time). This provides some protection against errors. Because keystroke reading over time is not continuous but digital, the keyboard is not well suited to real-time applications. Since humans are real-time creatures, this is a weakness. The designer must realize that use of the keyboard will lengthen the distance from real-time interaction with the user.

Paddles

Paddles are the only true analog input devices readily available for the system. As such, they suffer from the standard problem all analog input devices share: the requirement that the user make precise settings to get a result. Their angular resolution is poor, and thermal effects produce slightly fluctuating readings in even an untouched paddle.

The primary value of paddles is twofold. First, they are well suited for choosing values of a one-dimensional variable. People can readily absorb the idea that the paddle sweeps through all values and that pressing the trigger makes the selection known. Second, the user can sweep from one end of the spectrum to the other with a twist of the dial, which makes the entire spectrum of values immediately accessible.

An important factor in the use of paddles is the creation of a closed input/output loop. In most input processes, it is desirable to echo inputs to the screen so that the user can verify the input that was entered. This echoing process creates a closed input/output loop. Information travels from the user to the input device (paddles) to the computer, then back through the video display to the user. Because it is difficult for the user to verify the position to which the paddle has been set, it is essential that the program echo the paddle input.

Any set of inputs that can be meaningfully placed along a linear sequence can be addressed with a paddle. For example, menus can be addressed with a paddle. The sequence is from the top of the menu to the bottom. It is quite possible (but entirely unreasonable) to substitute a paddle for a keyboard. The paddle could sweep through the letters of the alphabet, with the current letter being addressed shown on the screen. Pressing the paddle trigger would then select the letter. While this scheme would not produce any typing speed records, it could be useful for

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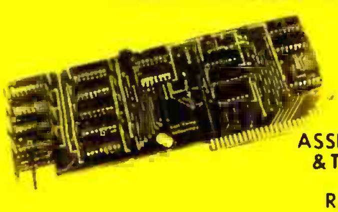

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children, and the concept can be applied to other selection problems.

Joysticks

Joysticks are the simplest input devices available for the computer. Since they are very sturdy, they can be used in harsh environments. They contain only five switches (one for the red button on the joystick and one for each of the four principal directions of the compass). For this reason, their expressive power is frequently underestimated. Joysticks, however, are surprisingly useful input devices. When used with a cursor, a joystick can address any point on the screen and can indicate a selection with the red button. With proper screen layout, the joystick can thus provide a wide variety of control functions. I have used a joystick to control a nuclear reactor (in the game Scram) and run a war game (in Eastern Front 1941).

The key to proper use of the joystick is the realization that the critical variable is not the selection of a switch, but the duration of time for which the switch is pressed. By controlling how long the switch is pressed, the user determines how far the cursor moves. This normally requires a constant-velocity cursor, which introduces a difficult trade-off. If the cursor moves too fast, the user will have difficulty positioning it on the item of choice. If the cursor moves too slowly, the user will become impatient waiting for it to traverse long screen distances. One solution to this problem is an accelerating cursor. If the cursor starts moving slowly and accelerates if it remains in motion past a set length of time, the user can have both fine positioning and high speed.

The real value of the joystick is its high tactility. The joystick involves the user in inputs in a direct and sensory way. The tactility of the keyboard is not emotionally significant. A joystick makes sense—push up to go up, push down to go down. If the cursor reflects this on the screen, the entire input process makes much more sense to the user.

Joysticks do have their limitations. Although it is possible to press the joystick in a diagonal direction and get a correct reading of the direction, the directions are not distinct enough to allow diagonal entries as separate commands. Just as some words (e.g., "library," "February") are difficult to enunciate clearly, some diagonal orders are difficult to enter distinctly. Thus, diagonal values should be avoided unless they are used in the pure geometrical sense: up on the joystick means up, right means right, and diagonally means diagonally.

Recap

We have discussed a number of features and devices that, taken together, constitute the elements of a language for interaction between the computer and the user. The features are:

- shapes
- color
- animation
- sound

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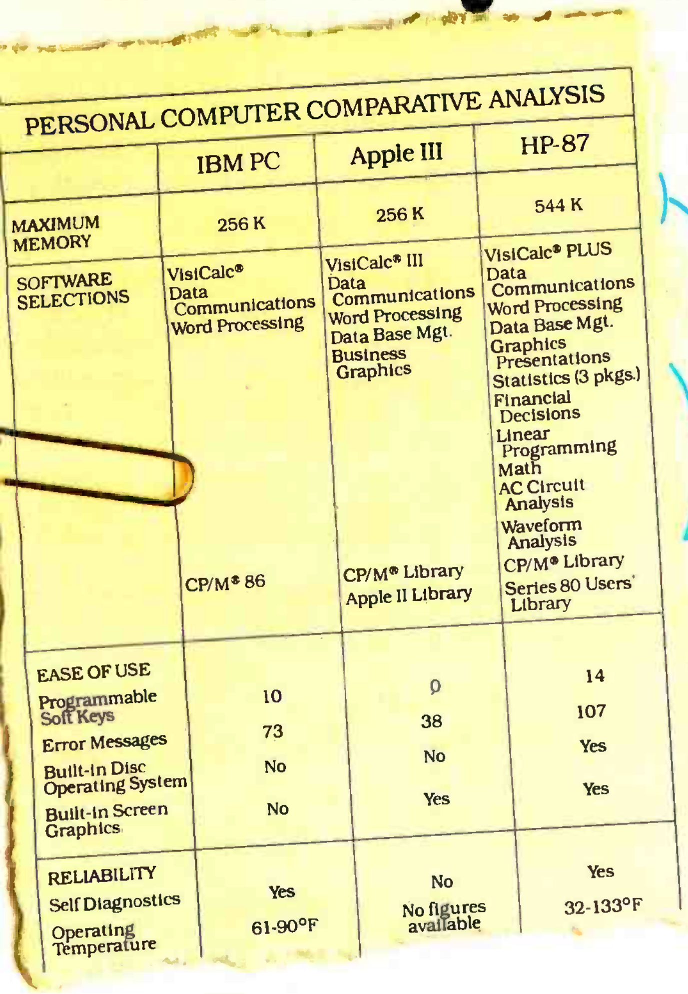

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The devices are:

- keyboard
- paddles
- joystick

How do we assemble all these elements into an effective language? To do so, we must first determine the major traits we expect of a good language:

- completeness
- directness
- closure

Completeness

The language must completely express all the ideas that need to be communicated between the computer and the user, but it need not express ideas internal to either thinker's thought processes. For example, the language used in Star Raiders must express all concepts related to the control of the vessel and the combat situation. It need not express the player's anxiety or the flight-path intentions of the Zylon enemy ships. These concepts, while germane to the entire game function, need not be communicated between user and computer.

Completeness is an obvious function of any language, one that all programmers recognize intuitively. Problems with completeness most often arise when the programmer must add functions to the program, functions that cannot be supported by the language the programmer has created. This can be quite exasperating, for in many cases the additional functions are easily implemented in the program itself. The limiting factor is always the difficulty of adding new expressions to the language used between the human and the computer.

Directness

Any new language is difficult to learn. Nobody has time to waste in learning an unnecessarily florid language. The language a programmer creates must be direct and to the point. It must rely as much as possible on communications conventions that the user already knows and must be emotionally direct and obvious. For example, a CTRL-X keystroke is obscure. What does it mean? Perhaps it means that something should be destroyed; X implies elimination or negation. Perhaps it implies that something should be examined, expunged, exhumed, or something similar. If none of these possibilities is indeed the case, the command is unacceptably indirect. Keyboards are notorious for creating this kind of problem.

Closure

Closure is the aspect of communications design that causes the greatest problems. The concept is best explained with an analogy. The user is at point A and wishes to use the program to get to point B. A poorly designed program is like a tightrope stretched between points A and B. The user who knows exactly what to

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do and performs perfectly will succeed. More likely, he or she will slip and fall. Some programs try to help by providing a manual or internal warnings that tell the user what to do and what not to do. These are analogous to signs along the tightrope advising "BE CAREFUL" and "DONT FALL." I have seen several programs that place signs underneath the tightrope, so that the user can at least see why the fall is happening. A somewhat better class of programs provides masks against illegal entries, equivalent to guardrails alongside the tightrope. These do help, but they must be well constructed to ensure that the user does not thwart them. Some programs have nasty messages that bark at the errant user, warning against making certain entries. These are analogous to scowling monitors in school corridors, and they are useful only for making an adult feel like a child. The ideal program is like a tunnel bored through solid rock. There is but one path, the path leading to success.

The essence of closure is the narrowing of options, the elimination of possibilities, and the placement of rock-solid walls around the user. Good design is not an accumulative process of piling lots of features onto a basic architecture; good design requires the programmer to strip away minor features, petty options, and general trivia.

While the strengths of the keyboard are undeniable, its weaknesses are seldom recognized.

This contention clashes with the values of many programmers, who crave complete freedom to exercise power over the computer. Their most common complaint against a program is that it somehow restricts their options. Thus, deliberate advocacy of closure is met with shocked incredulity. Why would anyone be so foolish as to restrict the power of this wonderful tool?

The answer lies in the difference between the consumer and the programmer. The programmer's life is devoted to the computer; the consumer is a casual acquaintance at best. The programmer uses the computer so heavily that it is cost-effective to take the time to learn to use a more powerful tool. Since the consumer does not have such time to lavish on the machine, a simple, quick operation is required. The fine points that a programmer dotes on are not important to the user; nor are the bells and whistles cherished by programmers. As a programmer, you may not share or approve of the consumer's values. But if you want to maintain your livelihood, you had better cater to them.

Closure is obtained by creating inputs and outputs that do not admit illegal values. This is extremely difficult to do with a keyboard, for a keyboard always allows more entries than any real program would need. This provides an excellent argument against the use of the keyboard. A joystick is much better because you can do so little with it, making it easier to conceptually exclude bad inputs. The ideal is achieved when all necessary options are expressible with the joystick and no further options will fit. In this case, the user cannot make a bad entry because it doesn't exist. More important, as in the language Newspeak in George Orwell's *Nineteen Eighty-four*, the user cannot even conceive bad thoughts because no words (inputs) for them even exist.

Closure is much more than masking out bad inputs. Masking makes bad inputs conceivable and expressible, but not functional. For example, a keyboard might be used with the "M" key disabled because it is meaningless. The user can still see the key, can imagine pressing it, and can wonder what would happen if it was pressed—all wasted effort. The user can waste even more time by pressing

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it and wondering why nothing happened. The waste is compounded by the programmer imagining the user doing all these wasteful things and putting in code to stop the symptoms without eliminating the disease. Why are these people wasting so much time over a button that doesn't do anything in the first place? A properly closed input structure avoids all these problems because it uses an input device that can express only the entries necessary to run the program—and nothing more. The user can't waste time dealing with something that isn't there, and the programmer can't waste time masking out bad inputs that can't be entered.

Closure provides an important feature for the beginning user: security. Imagine the naive user peering down at an army of deadly keys, each one laden with the potential for triggering World War III, or at least destroying the computer. A properly closed program offers fewer choices and fewer lurking disasters. Less perceived opportunity for failure generates confidence that, in turn, generates more fluent use of the program.

The designer must carefully weigh the capabilities of the machine and the needs of the user.

Many advantages accrue to the programmer when closure is properly applied. Code is tighter and runs faster because there need be no input error checking. Program structure is simpler because there are fewer logical tests and branches. Less testing is needed because there are fewer input conditions to test.

The primary problem with closure is the design effort that must be expended to achieve good closure. The entire relationship between the user and the program must be carefully analyzed to determine the minimum vocabulary necessary for the two to communicate. Numerous schemes of communication must be examined and discarded before the true minimum scheme is found. In the process, many bells and whistles that the programmer wanted to add will be eliminated. An objective viewpoint will conclude that the bells and whistles are more clutter than chrome.

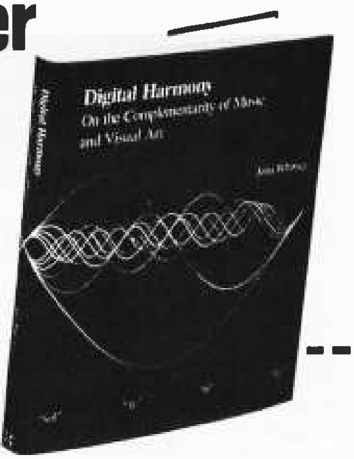
Conclusions

The design of the language of communication between the user and the program will be the most difficult part of the design process in consumer software. The designer must carefully weigh the capabilities of the machine and the needs of the user. The information that flows between the two sentient beings must be precisely defined. The language is then designed to maximize the clarity (not the quantity) of information flowing to the user while minimizing the effort the user must expend to communicate with the computer. The language must utilize the machine's features and devices effectively while maintaining its own completeness, directness, and closure.

The result will be a program that eliminates mental distance between the user and the computer. The two thinking beings achieve a mental resonance, an intellectual communion. ■

The Atari Tutorial ends this month with Chris Crawford's essay on human engineering. We at BYTE have been proud to present it to you, and we want to thank Chris Crawford, Bob Fraser, Kathleen Pitta, and Lane Winner for making it possible.

In the past year, the Atari 400/800 computer has become one of the most popular microcomputers. We plan to continue coverage of the Atari in BYTE, and we are very interested in seeing Atari-related articles from you. . . .G. W.



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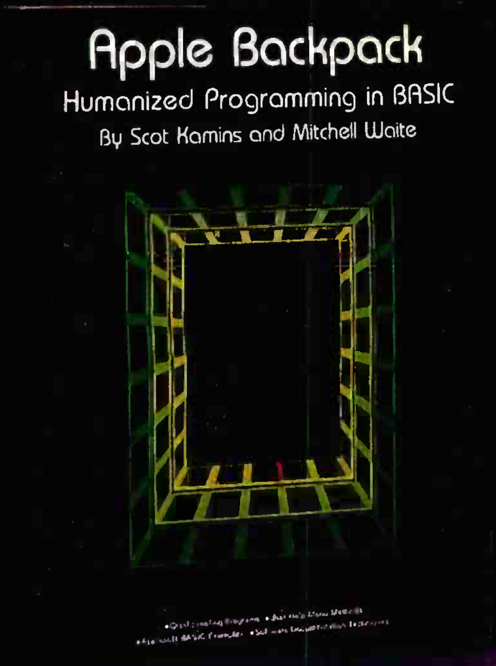

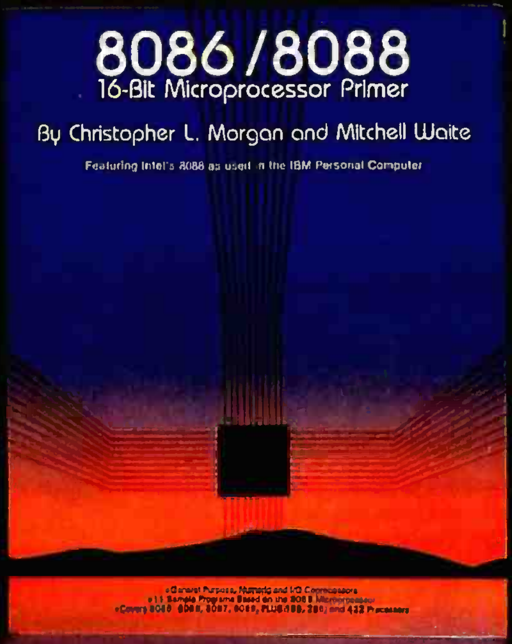

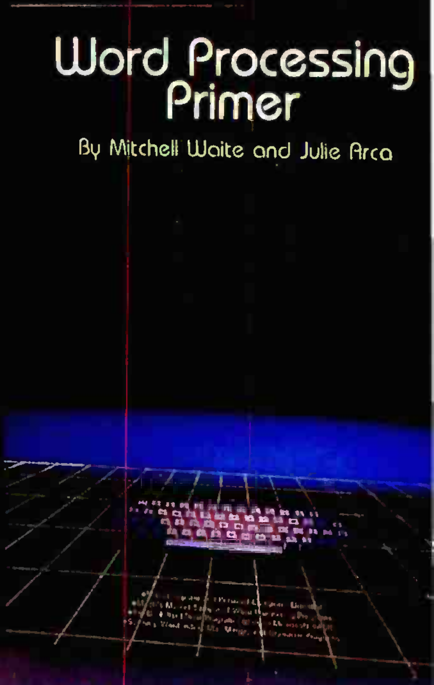

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Upward Migration

Part 1: Translators

Using translation programs to move CP/M-86 programs to CP/M and MS-DOS

Roger Taylor and Phil Lemmons
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In software migrations as in any other, the first thing you must know is where you are and where you are going. If a Californian decides to move to Australia, he can call an airline, ask for a ticket from San Francisco to Sydney, and the airline clerk will be happy to reserve a seat for him. If the Californian asks for a ticket from Los Angeles-or-San Francisco to Sydney, however, the airline clerk will find the request confusing. If the Californian asks for a ticket from Los Angeles-or-San Francisco to Sydney under Catholic rule, or a ticket from Los Angeles-or-San Francisco to Sydney under Protestant rule, the airline clerk will probably say, "You've already spent too much time in the hot tub, buddy. Stay in California. You're right where you belong."

In this little parable of modern times, Los Angeles is the 8080, San Francisco is the Z80, Sydney is the 8086, Catholicism is CP/M-86, and Protestantism is MS-DOS. The operating systems are represented by religions because they generate similar passions, controversies, true believers, and skeptics.

XLT86 takes 8080 source code and converts it into 8086 source code in an intelligent manner using data-flow-analysis techniques.

Is there really any need to explain why Los Angeles stands for the 8080 and San Francisco for the Z80? Or that the airlines stand for the software houses that have written translation programs?

You've probably guessed who the guy is who's trying to buy the ticket. He's the experienced 8080 or Z80 programmer, and the hot tub symbolizes his strong preference for staying right where he is—on one familiar processor with one familiar operating system. What could be cozier?

The programmer may not have the urge for going, but he has to go to one unfamiliar processor and to both operating systems. And so do the rest of us.

We're lucky to have software from at least three companies to help us along. In this article, the first of two parts, we will review three CP/M-80-to-8086 translator programs. We'll

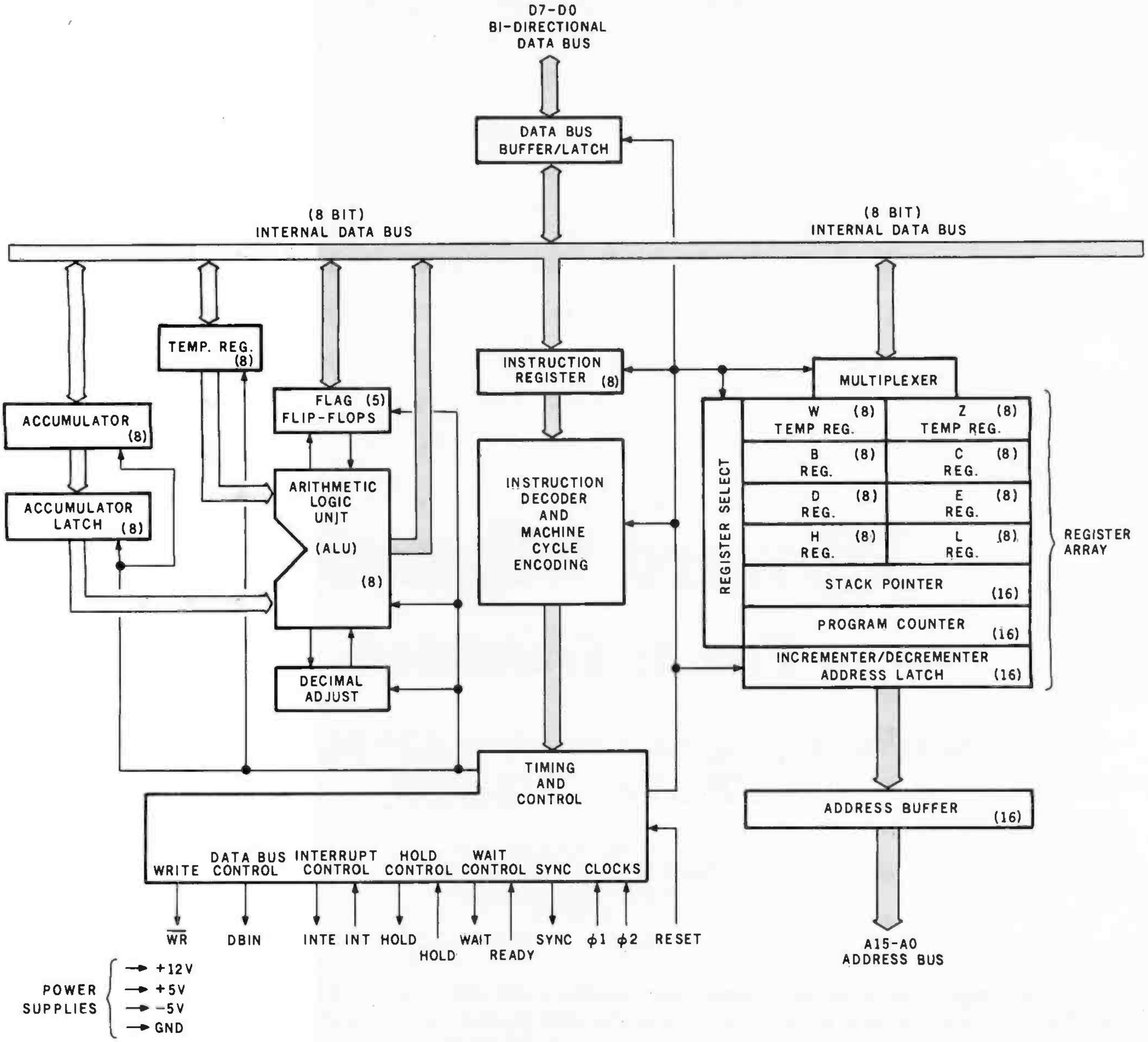

Figure 1: *Architecture of the 8080 microprocessor showing the internal registers.*

show the output that each of the three translators produced from the same original code. In addition, we'll make some observations about the differences in adapting the translated code to CP/M-86 and MS-DOS. Next month, we'll take a closer (although still not comprehensive) look at CP/M-86 and MS-DOS.

Orientation to the 8086

The first thing we have to do is examine the differences between the familiar 8080 and Z80 microprocessors and the 8086. For reference, figure 1 shows the registers and architecture of the 8080; figure 2 shows the registers and architecture of the Z80. We'll make few comments about these registers because they are familiar to you if you have 8080 or Z80 source code that you want to translate.

Figure 3 shows the registers and architecture of the 8086. Since the 8086 is less familiar, we'll take a brief look at it for orientation. (For further enlightenment, see *The 8086 Book*, Russell Rector and George Alexy, Osborne/McGraw-Hill, 1980, and *The 8086 Primer*, Stephen P. Morse, Hayden, 1980.) The 8086 is, of course, a 16-bit microprocessor. The 8088 is the same as the 8086 internally. Externally, however, they appear different due to the 8-bit bus of the 8088 and the 16-bit bus of the 8086. This means that programs that run on the 8088 will also run on the 8086 assuming that the memory resources and peripheral resources are the same. In general, statements in this article that apply to the 8086 apply to the 8088 as well.

The 8086 can access up to 1 megabyte of memory and as many as 65,000 input/output ports. The megabyte of memory is 2^{20} 8-bit bytes; any two consecutive bytes are a 16-bit word. Some 8086 instructions access bytes; others access words.

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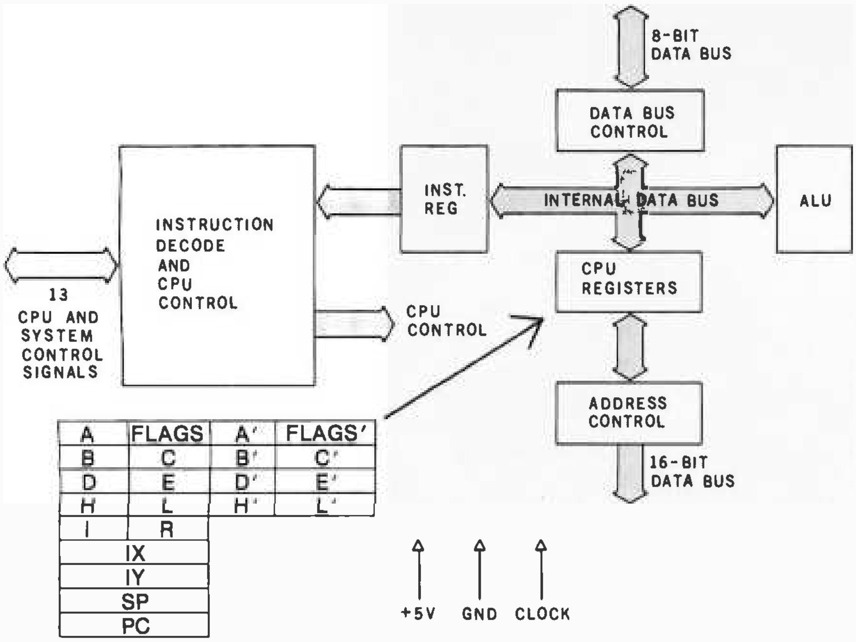

Figure 2: *Architecture of the Z80 microprocessor showing the internal registers.*

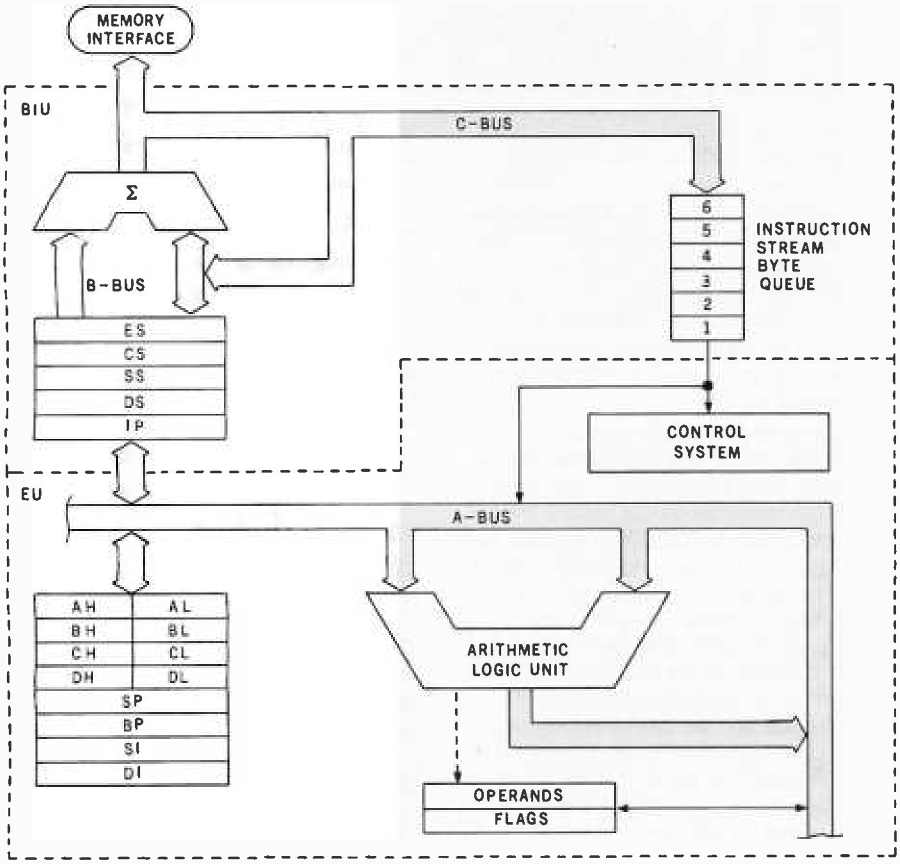

Figure 3: *Architecture of the 8086/8088 microprocessor showing the internal registers.*

Sixteen bits are not enough to address a megabyte of memory. The 8086 manages to do so, however, by dividing the megabyte of memory into a number of segments of 64K bytes each. Each segment begins at an address that yields an even result when divided by 16.

All calculations of memory addresses in the 8086 involve four special registers called segment registers. The 8080 family has a 16-bit address bus that allows addressing of 65,536 bytes of memory. While the internal registers of the 8088/8086 family also have 16 bits, the external address bus has 20 bits. To get the 20-bit address, the 8086 extends a segment register with 4 low-order bits of 0, and adds the segment register to a 16-bit address from another register, as shown in figure 4.

Each segment register defines what is known as its own "current" segment. Each instruction specifies an offset into a segment. The segment registers, which *cannot* be used interchangeably, are as follows:

CS—The Code Segment register defines the 64K-byte current code segment. When an instruction is fetched, the contents of the program counter are added to the CS register contents to calculate the address of the instruction to be fetched.

DS—The Data Segment register defines the current data segment. With three exceptions, all data memory references are understood in relation to the DS register. (The exceptions are that the stack pointer is used to calculate stack addresses, any data memory addresses calculated using the BP register are taken in relation to the stack segment, and any string operations involving the destination are taken in relation to the extra segment. See *SS* and *ES* immediately below.)

SS—The Stack Segment register identifies the current stack segment. References to data memory that use the BP or SP register in calculating the address are understood in relation to the SS register. For example, the PUSH, POP, CALL, INT, and RET instructions use the SS register.

ES—The Extra Segment register plays

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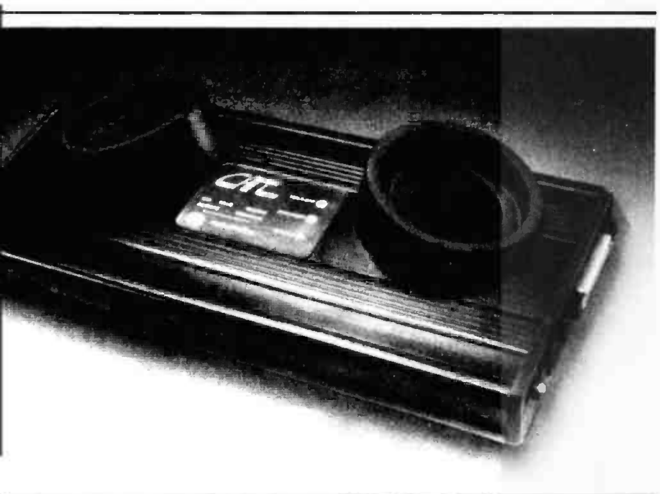

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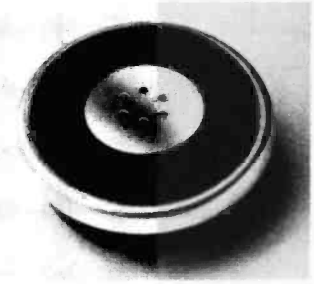

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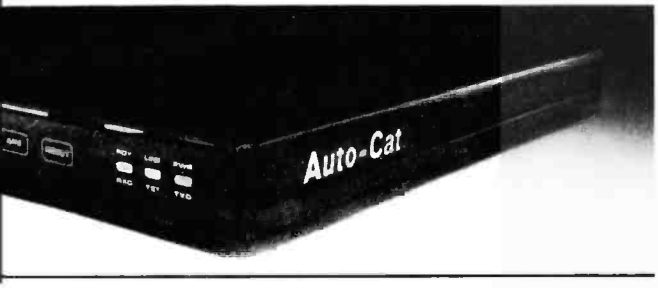

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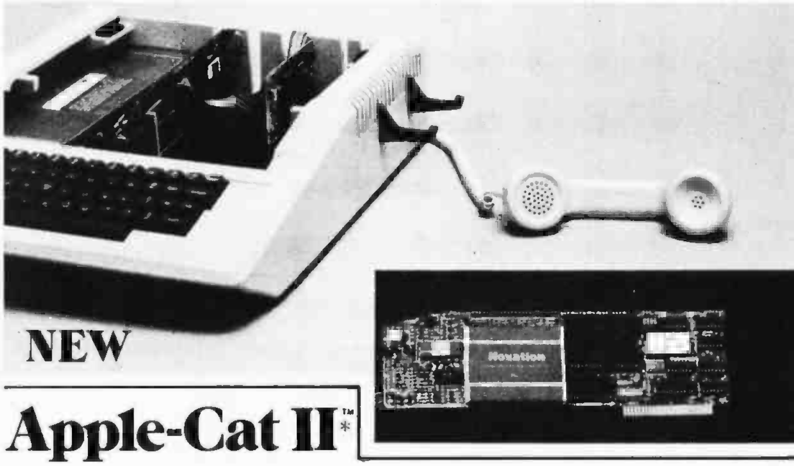

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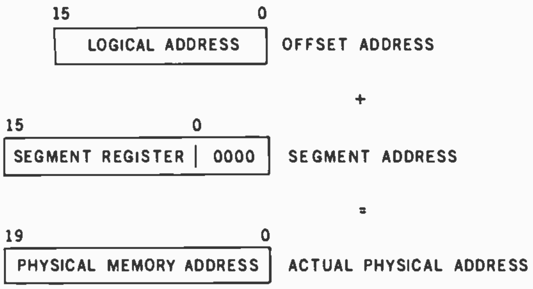

Figure 4: *The 8086 extends a segment register with 4 low-order bits of 0. It then adds the segment to a 16-bit address from another register to achieve a 20-bit address.*

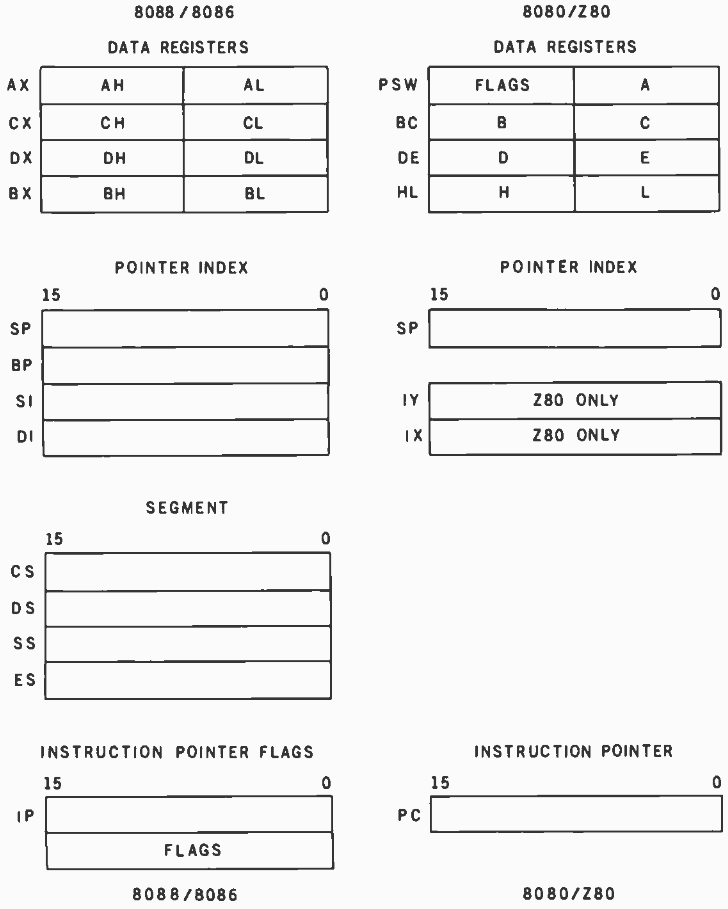

Figure 5: *Register-usage mapping between the two processor families is shown. Note that the IX and IY registers of the Z80 do not exist for the 8080/8085. More registers are in the 8088/8086 than in either the 8080 or Z80. Observe that the 8088/8086 segment registers have no parallel in the 8080/Z80 family. The 8080 family has a 16-bit address bus that allows addressing of 65,536 bytes of memory. While the internal registers of the 8088/8086 family also have 16 bits, the external address bus has 20 bits, formed by extending a segment register with 4 low-order bits of 0, and adding it to a 16-bit address from another register.*

a role in string operations. All destinations of string operations use the DI register in calculating addresses, and are taken relative to the ES register.

Besides the four segment registers, the 8086 has the following:

- Four general-purpose registers: AX, BX, CX, and DX. Each is addressable as a 16-bit register or as two 8-bit registers. When addressed as 8-bit registers, the pairs are called: AH, AL; BX, BL; CH, CL; and DH, DL. The general-purpose registers hold the intermediate results of operations.
- Four pointer and index registers; these locate data within a specified segment of memory. SP is the stack pointer, BP the base pointer, SI the source index, and DI the destination index.
- One program counter.
- One 16-bit flag register (program status word, or status register) containing nine flags.

Now that we've looked inside the 8086, we can take a look at how register usage in the 8080/Z80 processor family corresponds generally with that in the 8086. Figure 5 shows the sets of registers alongside each other so that you can see the general correspondence clearly. Note that the IX and IY registers of the Z80 do not exist for the 8080/8085. On the other hand, the alternate register set of the Z80 (not shown) as well as the I and R registers have no parallel in the 8086 register set; operations involving these will require special attention from the programmer after the conversion is done.

Clearly, the 8086 has more registers than either the 8080 or Z80. Since the 8086 also has a more powerful instruction set, translation should be possible with minor restrictions.

Complications

Since all CP/M-80 programs had to exist in a 64K-byte region, there should be little trouble fitting a translated program into a 1-megabyte (1,048,576-byte) region. If you're translating from the Z80, however, things are complicated slightly

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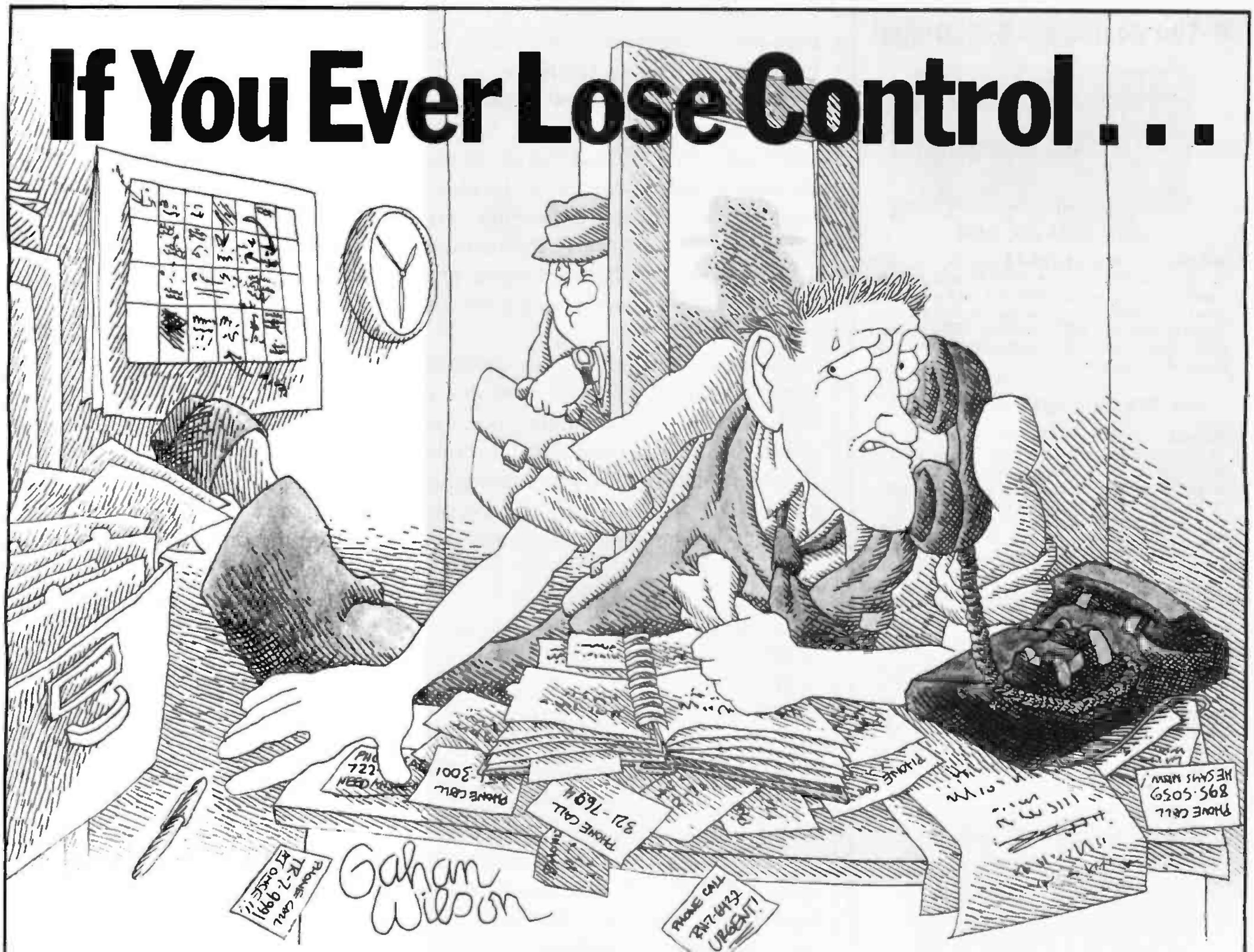

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because its extensive instruction set has to be mapped to the 8086 instructions, as well as the 8080 registers.

The 8086 does, however, have a rich instruction set that covers all the bit instructions and most of the block instructions. The problems encountered in mapping instructions and registers can be formalized and solved by using a variety of software tools.

To convert a source file running under CP/M-80 so as to assemble it with an 8086 assembler requires either the use of a code translator or a considerable effort with a program editor. At least three commercial products come under the translator category:

- XLT86 from Digital Research Inc.
- TRANS86/ACT86 from Sorcim
- The Z80-to-8086 translator from Seattle Computer Products

Intel also has a translator, CONVERT 86, but it is sold only as part of a large software package intended for its OEM customers and doesn't run under CP/M. In addition, some reports indicate that Microsoft may soon bring out a translator.

Two issues must be addressed when converting from a CP/M-80 source:

1. Where is the source coming from?

   Z80 instruction mnemonics?
   (a) Zilog
   (b) TDL (Technical Design Labs)
   (c) Intel (Digital Research with macros)
   (d) Sorcim/ACT-80

   or

   Straight 8080/8085 code with no macros?

2. Where is the resultant code going?

   CP/M-86 or MS-DOS?

The three translators under review do not always approach these issues in the same way. Furthermore, they all handle register mapping somewhat differently. We'll look at the translators now one at a time. Then we'll see how they translated the same CP/M-80 listing. With the listing in hand, we'll see how each of the translators handled register mapping. Finally, we'll turn to the subject of how the two different 16-bit operating systems affect program translation.

XLT86 from Digital Research

Digital Research's XLT86 takes standard 8080 source code in a format compatible with ASM, MAC, or RMAC assemblers and converts the 8080 source code to 8086 source code in a format compatible with *ASM86* operating under either CP/M-80 or CP/M-86. Since XLT86 is written in PL/I-80, the translator can run either stand-alone under CP/M-80 or for cross development under VAX/VMS. It produces optimized 8086 code in a five-phase, multipass process, doing global data-flow analysis to determine optimal register usage.

Although macro definitions are not supported, conditional-assembly directives are. The *XLT86 User's Guide* suggests that if you want macro expansion, you can use a pass through MAC or RMAC to produce a PRN file that can be edited (removing the first few columns of generated hexadecimal code) to produce an expanded source file for input acceptable to XLT86. XLT86 does not recognize Z80 instructions. XLT86 passes repeat loops through to the 8086 source code.

XLT86 analyzes the source program in its entirety, determining the block structure and the register/flag usage. Working from this information, it translates the code to 8086 assembler code in an optimized way. The decision algorithm for each instruction type is given in a section of the manual to allow the user to see what happens in each situation.

Register mapping generally follows the correspondence shown in figure 4, with a loose relationship between the 8086 AX and the 8080 PSW; the exact relationship is determined from register usage at translate time.

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cess, both on the command line and embedded in the 8080 source text. The options control the disks that the work and output files are on, whether the block-analysis information is output to disk, whether code and data segments are to be intermixed or kept separate, and whether the condition flags are active on exiting from subroutines.

XLT86 is a sophisticated program that does a reasonable job of optimizing the translation of 8080 source code to 8086 source code. BDOS calls from CP/M-80 are mapped into BDOS calls that are compatible with CP/M-86.

XLT86 has special features for handling translation of conditional JMP and CALL instructions in 8080 source code. In the 8080 instructions, JMP and CALL instructions are capable of reaching any address within the 64K-byte region. The 8086 conditional JMP instructions can reach only 128 bytes on either side of the IP (Instruction Pointer) register. XLT86 examines the target of the conditional JMP. If the target cannot be reached, XLT86 changes the sense of the conditional JMP and skips over a long JMP to the target address. Since there are no conditional CALL or RET instructions in the 8086, the sense of the condition is changed and a short conditional JMP is performed to skip over an unconditional CALL or RET.

The 8086 can access up to 1 megabyte of memory and as many as 65,000 input/output ports.

As noted earlier, the segment registers allow for separation of code and data regions. To reference data, you have to tell the 8086 whether data is in the code segment (CS) or the data segment (DS). For the Digital Research ASM86 assembler, the Offset directive handles this chore. XLT86 examines an expression and determines the proper segment for the particular instruction.

XLT86 does have limits on the size of the 8080 source files that it can translate because the flow-analysis information must be in memory. In a 64K-byte CP/M system, the maximum source file that can be translated is approximately 6K bytes, depending on the structure of the program. Nothing is said in the manual about being able to deal with modular code using RMAC and external references. This implies that the entire source program must be converted at once, limiting the size of the program that can be translated by using XLT86 to 6K bytes.

In summary, if you're starting from 8080/8085 assembly code written for ASM or MAC and you want to go to CP/M-86, and if the source program does not exceed 6K bytes, XLT86 is the most useful translator. Code written for Z80s using MAC requires careful examination after the translation process to make sure that no

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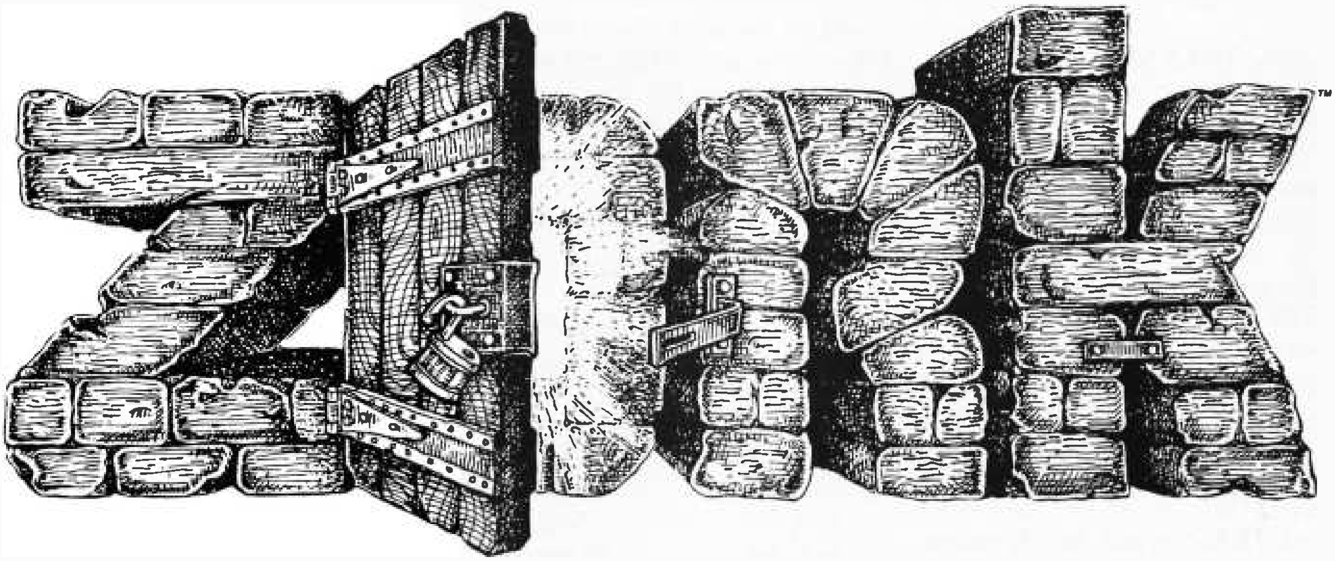

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flags were inadvertently changed. You have to expand macros before using XLT86 unless the number of invocations was small. In that event, expanding the macros by hand with an editor might be just as easy.

Sorcim's TRANS86

TRANS86 is an 8080/ACT80-to-8086 translator. It takes 8080 or ACT80 source code as input and creates a file compatible with the input to ACT86, an 8086 assembler.

The output of TRANS86 is incompatible with any assembler other than ACT86. The ACT86 mnemonics are different enough so that, unless the programmer has a sophisticated text processor and the talent (or patience) to do a great deal of text manipulation, TRANS86 should be used only with ACT86.

Both TRANS86 and ACT86 run on either 8080 or Z80 processors under CP/M-80, MP/M, or CDOS with a minimum of 24K bytes of RAM (random-access read/write memory). TRANS86 consists of an executable file, an overlay file, and a translation table. The input assembly source code must be in a form acceptable to the standard CP/M-80 assemblers (ASM, MAC, or RMAC), or to ACT80, Sorcim's Assembly Code Translator for 8080/Z80 processors.

Translation occurs on an instruction-by-instruction basis with some optimization rules applied to conditional jumps. There appears to be no limit as to the size of the source file that can be translated. A file is produced on the same disk as the source file with the same name and an .ASN extension. If a file by that name already exists, the user is asked if the file should be deleted or if the program should be aborted.

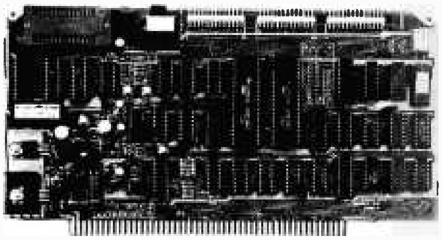
TRANS86 flags the following Z80 instructions as errors:

ACT80 code	Zilog/Mostek equivalent code
Mov A,R	Ld A,R
Mov R,A	Ld R,A
Mov A,I	Ld A,I
Mov I,A	Ld I,A
In,C reg	In reg,(C)
Inir	Inir
Otir	Otir
Rld	Rld
Rrd	Rrd

TRANS86 supports macros in the ACT80 format. Although TRANS86 acts on macros in the MAC format, there is no guarantee that the macros will expand correctly. The user is cautioned to examine the result of a macro expansion to determine if the sense of the macro has been maintained. Examples are given of some macros that work and some that do not. The *TRANS86 User's Reference Manual* includes a section that gives hints on how to hand-optimize the output of TRANS86; specifically, accumulator indirect loads through the DE and BC registers, 8080 conditional jumps, and Z80 block instructions.

Another section describes the differences between ACT80 and Z80 mnemonics. This information allows the programmer to manually convert assembly source code to a form acceptable to TRANS86. The ACT80 instruction set has some ASM-style instructions, some Z80-style instructions, and some instructions that are unique to the ACT80 assembler. If the source code is written in 8080 ASM mnemonics, TRANS86 will process it and output ACT86 assembler code. The 8080 instruction SPHL, however, was translated incorrectly in the current version of TRANS86.

Another section in the manual contains suggested constructions that can be manually entered to deal with Z80 op codes that are flagged as errors. Block input/output instructions and input/output through register C are described in detail.



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Seattle Computer System

Seattle Computer Products' (SCP) translation system consists of two programs: a Z80 translator (called TRANS86 on the disk, though *not* the same as Sorcim's) and a compatible 8086 cross assembler (ASM86). Both programs run on Z80 processors under CP/M-80 with a minimum of 24K bytes of RAM. The programs do not run on 8080/8085 processors.

The translator accepts source files in Zilog/Mostek mnemonics and produces an 8086 assembler source file in a form acceptable to the SCP 8086 cross assembler. Since the 8086 source format required by the SCP 8086 cross assembler is different from any other 8086 assembler that we know of, you must use these two programs together. The translator places its output on the same disk as the Z80 source code and gives it an .A86 file extension.

The translation is on an instruction-by-instruction basis with no optimization. There appears to be no limit on the file size that may be translated. Not all Z80 instructions are translated, however. Those in the following list will produce an op code error:

Cpd
Cpi
Ind
Indr
Ini
Inir
Ldd
Ldi
Otdr
Otir
Outd
Outi
Rld
Rrd

These op codes are mostly in the block-manipulation set of instructions. Although programmers do use these instructions, they must be manually coded when converting to the 8086. The SCP translator does not support macros and permits use of the following pseudo-ops only:

Db
Dm
Ds
Dw
Equ
If/Endif
Org

If the Z80 index registers IX and IY are used, they are mapped into memory locations with the labels IX: and IY:. The programmer has to define these locations; otherwise, they will show up on the assembly listing as undefined labels. The Z80 alternate register set (BC',DE',HL') is treated the same way, as memory locations that the programmer must define.

Either the DI or SI register can be used as a temporary IX register by loading one of them from the location IX when required to do indexed instructions. The programmer has to take care of this substitution; the translator does not.

When using the DI register, you must always keep in mind that the only 8086 segment base that can be used with the DI register is the ES segment; the SI register, on the other hand, can reference all the segment bases, defaulting to the DS segment. If this 8086 source code is going to be run under CP/M-86, you have to be careful about using the ES segment register. The CP/M-86 documentation specifically states that ES is not saved through a BDOS call.

For the SCP Z80-to-8086 translator's register usage, see figure 6b.

Translating the Test File

To determine how the three programs actually translate source text, we prepared a file acceptable as input to an assembler and containing all the op codes of the 8080 and Z80. Since the SCP translator could accept only Zilog/Mostek mnemonics, the test text was run through an 8080-to-Z80 filter program before the translation.

Listing 1 presents, side by side and line by line, the original 8080 code, the Sorcim TRANS86 translation, the Seattle translation, and the XLT86 translation. Here are reminders of some things to consider when you examine the translations:

- Because of the differences in the architectures of the 8086 and the 8080/Z80, some choices must be made when translating from one architecture to the other. Therefore, some difference in translation is to be expected.

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(a)

	8080/8085	TRANS86	8086/8088 Seattle	XLT86
8-bit registers	A	AL	AL	AL
	B	CH	CH	CH
	C	CL	CL	CL
	D	DH	DH	DH
	E	DL	DL	DL
	H	BH	BH	BH
	L	BL	BL	BL
16-bit register pairs	PSW	AX(1)	AX	AX
	BC	CX	CX(2)	CX(2)
	DE	DX	DX(2)	DX(2)
	HL	BX	BX	BX
16-bit register pairs	SP	SP	SP	SP
	PC	IP	IP	IP

(1) TRANS86 does not preserve 8080 byte order on the stack.
(2) The Seattle translator uses SI on loads from memory and DI for stores to memory. TRANS86 and XLT86 do a register exchange between BX and the appropriate register to allow indirect addressing through BX, then a register exchange to fix up BX and the appropriate register.

(b)

	Z80	TRANS86	8086/8088 Seattle	XLT86
8-bit	R	(3)	(3)	(3)
	I	(3)	(3)	(3)
16-bit	IX	DI	(4)	(5)
	IY	SI	(4)	(5)
alternate registers set	BC'	(5)	(4)	(5)
	DE'	(5)	(4)	(5)
	HL'	(5)	(4)	(5)

(3) Since the 8086 does not have equivalent registers, none of the translators support these registers. However, they can be mapped to a memory location by the programmer.
(4) Seattle's TRANS86 handles these registers by generating memory references to storage locations defined by the programmer.
(5) Although these registers are not mapped by the translators, the programmer can define storage locations and deal with them through macro definitions.

Figure 6: *8080/8085/Z80-to-8086/8088 register mapping. Figure 6a shows 8080/8085-to-8086 register mapping by the three translator programs. Figure 6b shows Z80-to-8086 register mapping by the three translator programs.*

- In general, when the 8080 does 16-bit arithmetic, only the carry bit is affected; this is definitely not so in the 8086.
- The Z80 and 8086 do string and block operations differently; the 8080 has no primitive block operations at all.
- As noted earlier, the segment registers in the 8086 allow addressing of up to 1 megabyte; no corresponding registers exist in either the 8080 or Z80.
- Registers used for indirect memory references in the 8080/Z80 are different from the corresponding mapped registers in the 8086.
- Conditional jumps in the 8080/Z80 can reach anywhere in its address space; conditional jumps in the 8086 can reach only 128 bytes on either side relative to the IP register.
- No conditional calls in the 8086 correspond to the conditional calls of the 8080/Z80.

Listing 1 makes it apparent that the three translators treat most instructions the same way, allowing for the differences in the target instruction set. The following comments highlight the differences found.

The only incorrect translation is TRANS86's rendering of the SPHL instruction. The transfer is in the wrong direction. The comment field of the instruction was wrong in the

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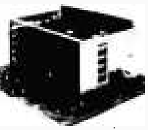

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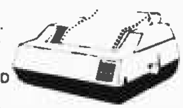

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Listing 1: *The original 8080 code, the Sorcim TRANS86 translation, the Seattle translation, and the XLT86 translation.*

```
Original
8080 code    TRANS86        Seattle          XLT86

Stax B       Xchg BX,CX     Mov DI,CX        Mov SI,CX
             Sto AL,[BX]    Stob             Mov [SI],AL
             Xchg BX,CX

Inx B        Inc CX         Lahf             Lahf
                            Inc CX           Inc CX
                            Sahf             Sahf

Dad B        Add BX,CX      Lahf             Lahf
                            Add BX,CX        Add BX,CX
                            Rcr SI           Sahf
                            Sahf
                            Rcl SI

Ldax B       Xchg BX,CX     Mov SI,CX        Mov SI,CX
             Ld AL,[BX]     Lodb             Mov AL,[SI]
             Xchg BX,CX


Stax D       Xchg BX,DX     Mov DI,DX        Mov SI,DX
             Sto AL,[BX]    Stob             Mov [SI],AL
             Xchg BX,DX

Ldax D       Xchg BX,DX     Mov SI,DX        Mov SI,DX
             Ld AL,[BX]     Lodb             Mov AL,[SI]
             Xchg BX,DX

Dad H        Add BX,BX      Lahf             SHL BX,1
                            Add BX,BX
                            Rcr SI
                            Sahf
                            Rcl SI

Dec H        Dec BX         Lahf             Dec BX
                            Dec BX
                            Sahf

Inr M        Incb [BX]      Inc B,[BX]       Inc Byte Ptr 0[BX]

Mvi M,3      Stob #3,[BX]   Mov B,[BX],3     Mov Byte Ptr 0[BX],3

Dad SP       Add BX,SP      Lahf             Add BX,SP
                            Add BX,SP
                            Rcr SI
                            Sahf
                            Rcl SI

Dcx SP       Dec SP         Lahf             Dec  SP
                            Dec SP
                            Sahf

Mov M,A      Sto AL,[BX]    Mov [BX],AL      Mov Byte Ptr 0[BX],AL

Rnz          Jz :G1         Jnz Ret          Jz L 1
               Ret                             Ret
             :G1:                            L 1:

Jnz Help     Jz :G2         Jnz Help         Jz L 2
               Jmp Help                        Jmp Help
             :G2:                            L 2:
```

Listing 1 continued on page 340

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Listing 1 continued:

```
Cnz Help       Jz :G3         Jz X000        Jz L 3
                 Call Help     Call Help      Call Help
               :G3:           X000:          L 3:

Xthl           Mov BP,SP      Pop SI         Mov BP,SP
               Xchg BX,[BP]   Xchg SI,BX     Xchg BX,[BP]
                              Push SI

Pop PSW        Pop AX         Pop AX         Pop AX
               Sahf           Xchg AH,AL     Xchg AL,AH
                              Sahf           Sahf


Push PSW       Lahf           Lahf           Lahf
               Push AX        Xchg AH,AL     Xchg AL,AH
                              Push AX        Push AX
                              Xchg AH,AL     Xchg AL,AH

Sphl           Mov BX,SP      Mov SP,BX      Mov SP,BX

(Z80 opcodes)

Djnz Label     Dec CX         Dec CH         -------
               Jnz Label      Jnz Label

Cpir           Xchg BX,DI     UP             -------
               Cld            Mov DI,BX
               Repnz          Repnz
               Scasb          Scab
               Xchg BX,DI     Mov BX,DI

Ldir           Xchg BX,SI     Up             -------
               Xchg DX,DI     Mov SI,BX
               Cld            Mov DI,DX
               Repnz          Rep
               Movsb          Movb
               Xchg BX,SI     Mov DX,DI
               Xchg DX,DI     Mov BX,SI

Push Ix        Push DI        Push [Ix]      -------

Pop  Iy        Pop  SI        Pop [Iy]       -------
```

translated text, also. We therefore suspect that the program has a minor bug with regard to this particular instruction.

Since this test program was nonsense as far as logical program flow is concerned, XLT86 was at a loss to determine the active registers, and sometimes chose simpler instructions than it would have in a real program. The results for XLT86 could be different in different situations.

The conditional jumps for TRANS86 and XLT86 can vary, depending on the distance of the target label from where the jump is.

The conditional return in Seattle's translator references a label called RET. This refers to any RET within 128 bytes on either side of the statement. This is one reason why Seattle's translator should be used with ASM86; no other assembler will take advantage of this feature.

Note that TRANS86 and the Seattle translator treat the DJNZ instruction differently. TRANS86 uses a 16-bit register, CX, and the Seattle translator uses CH, an 8-bit register. A warning message comes out of the Seattle translator reminding the programmer that DJNZ does not affect the flags in the Z80 but that this sequence of instructions will affect the 8086 flags.

Register Mapping

Figure 6 shows a detailed, side-by-side comparison of the differences in register mapping performed by the three translators. Figure 6a deals with the 8080/8085-to-8086 mapping; figure 6b, with Z80-to-8086 mapping.

As the notes there state, TRANS86 does not preserve 8080 byte order on the stack.

The Seattle translator uses SI on loads from memory and DI for stores to memory.

TRANS86 and XLT86 do a register exchange between BX and the appropriate register to allow indirect addressing through BX, then a register exchange to fix up BX and the appropriate register.

Since the 8086 does not have some of the registers of the Z80, the translators can't support them. The programmer can, however, map those registers to a memory location.

TRANS86 generates memory references to storage locations supplied by the programmer to take care of the Z80's IX, IY, BC', DE', and HL' registers.

Summing Up the Translators

A general view is that Sorcim's TRANS86 is a useful product if the original source is in 8080 or ACT80 form and the user has ACT86 as a target 8086 assembler. The register and flag usage appear to be a little looser than for the other two programs. This requires more knowledge and more involvement from the programmer to make sure that the sense of the translated code is maintained. No limitations exist as to the size of the source file and macros are supported if the input is in ACT80 format. Sorcim's TRANS86 is sold separately from ACT86, but they should be used together.

The Seattle Computer Products' Z80-to-8086 translator is a straightforward code translator that uses Zilog mnemonics and runs only on Z80-based processors. There appear to be no limitations as to the size of the source program that may be translated since the program translates one instruction at a time. Register and flag usage are very conservative, protecting the source architecture as much as possible and providing warnings when potential problems could arise. The converted program has more of a chance of working the first time than a less conservative translation would have.

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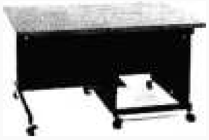

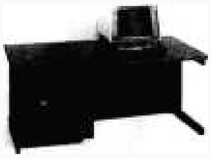

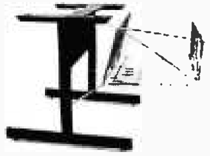

Once the program is working correctly, the programmer can reedit the 8086 source to trim out the unnecessary register saves and flag manipulations to speed up the code and make it smaller. If the source code is in Zilog mnemonics, or if a filter program is available to convert to Zilog mnemonics, we recommend the pair of programs from Seattle Computer Products. The Seattle translator and its ASM86 assembler should be used together for optimum benefit.

XLT86 from Digital Research is a program that takes 8080 source code and converts it into 8086 source code in an intelligent manner using data-flow-analysis techniques. It will produce better code than either of the other two translators if two conditions are met: (1) no Z80 instructions are used, and (2) the source code is not bigger than 6K bytes (assuming the CP/M system is a 64K-byte system). XLT86 should be used with ASM86 under either CP/M-80 or CP/M-86.

MS-DOS versus CP/M-86

In the trade press and various advertisements, we see claims that conversion of CP/M-80 programs to MS-DOS (IBM PC-DOS, Lifeboat Associates' SB-86, Seattle Computer Products' 86-DOS) is as easy, or even easier, than from CP/M-80 to CP/M-86. In fact, some differences are seen in interfacing to the two 16-bit operating systems. With the assumption that the program had to operate in a 64K-byte region under CP/M-80, we will bypass memory-allocation questions. The remaining issues that have to be addressed are:

- How does a program gain access to operating system resources?
- How are file control blocks used to manipulate files?

Gaining access to the operating system under CP/M-80 requires placing the function code in the C register, placing the information address in the DE registers, and calling location 05 hexadecimal, the CP/M-80 entry point. If the system call returns a value, it returns the value to the A register. A so-called warm boot under CP/M-80 is accessed by jumping to location 00 hexadecimal, which reads in the operating system and resets the disk system.

Now let's look at similar functions under CP/M-86 and MS-DOS.

Gaining Access to CP/M-86

Gaining access to CP/M-86 requires placing the function code in the CL register, placing the byte parameter in the DL register or placing the word parameter in the DX register, placing the data segment in the DS register (the data segment is usually not changed for a converted program), and executing a software interrupt, INT #224. The result is returned in the AL register if it is a byte value; if the result is a word value, it is returned in both the AX and BX registers. Double-word values are returned with the offset in the BX registers and the segment in the ES register. Conversion of programs from CP/M-80 to CP/M-86, then, requires replacing the call to location 5 with the software interrupt INT #224.

Another necessary change involves the warm boot. Under CP/M-80, the warm boot may be accessed by a system call with a function code of 0 for a jump to location 0. CP/M-86, however, does not support the jump to location 0. As a result, you must change this program exit in the translated program if the program is to run correctly.

Provided that the call to location 5 is replaced with INT #224, that the warm boot change is made, and that the registers are mapped correctly, there should be little problem in getting the translated program to access the CP/M-86 system functions.

Gaining Access to MS-DOS

Although MS-DOS has a "preferred" mechanism through a software interrupt, INT #33, for accessing the system, an additional mechanism is provided for "preexisting" programs that is compatible with CP/M-80 calling conventions, at least for functions in the range of

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0-36. As far as system calls within the allowed function range are concerned, the programmer doesn't have to do anything to translated programs to get them to run under MS-DOS other than to correctly map the registers.

MS-DOS also supports the warm boot function of CP/M-80. A jump to location 0 under MS-DOS executes a software interrupt, INT #32, which is functionally a program end and the normal way to exit from a program.

Manipulating File Control Blocks

The file control block used in CP/M-80 consists of a 36-byte block, which describes the disk drive on which to find or create the file, the file name, and information relating to which record of the file is desired.

At least so far as normal file-access requests are concerned, both MS-DOS and CP/M-86 treat this block of information the same.

System-level information is quite different in the two cases, and programs that look at system bytes within the file control block need to be changed for MS-DOS to function correctly. The MS-DOS file control block has many more features, including the date the file was created or last updated, the logical record size, and the file size. These system-information bytes are in areas within the file control block that application programs normally do not access. Nevertheless, converting programs to make use of MS-DOS file control blocks should take little effort.

The problems encountered in mapping instructions and registers can be formalized and solved by using a variety of software tools.

Conclusion

There is, in fact, little if any difference in the difficulty of translating sound CP/M-80 programs to CP/M-86 or MS-DOS. With CP/M-86, the programmer will have to make minor changes to gain access to the operating system. With MS-DOS, the programmer will have to make minor changes to handle the extra features of the MS-DOS file control blocks.

Next month, we will make further comparisons between MS-DOS and CP/M-86. We will include some benchmarks made with the Compupro 8085/8088 dual-processor S-100 system. We will report not only the results of running programs under both CP/M-86 and MS-DOS on the same 8088 in the same machine, but also the results of running the same programs under MS-DOS running Emulator-86 on the same 8088 in the same machine. Although that may sound more like a cat chasing its own tail than a test of operating systems, we will try to keep it all straight.■

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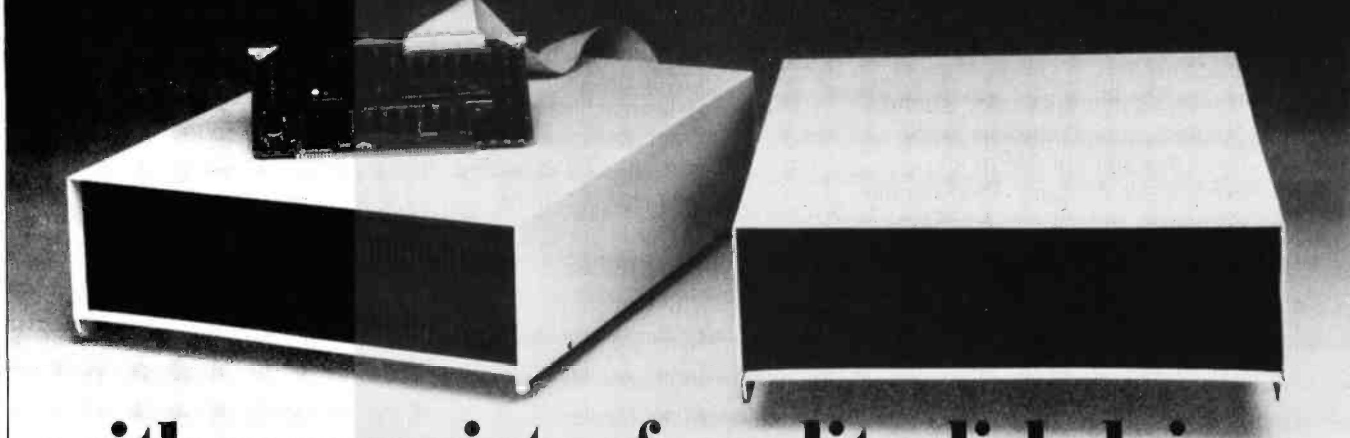

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MEM 3101	2/Sgl	Soft	10/S45 00
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Scotch 3M

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744-16	1/Sgl	Hard 16	10/S33 00
745-0	2/Dbl	Soft	10/S49 00
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1242-10	1/Dbl	Hard 10	10/S30.00
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The Osborne 1

Mark Dahmke
Consulting Editor

The Osborne 1 is Adam Osborne's solution to the problem of incompatibility among personal computers. Designed to use industry-standard software, it combines the best of several designs while compromising in only a few areas, such as color and graphics.

The Osborne 1 can best be classified as a business system because it was designed to run a word processor and have the standard printer and modem interfaces that would be most useful to a business person. If you are looking for a computer that you can play games on, the Osborne 1 is not for you. If you need a solid, well-supported, well-documented business system at a reasonable price, you should give it a great deal of consideration.

You really do get a lot for your money when you buy an Osborne 1. Just out of curiosity, I added up the manufacturers' suggested retail prices of all the software included with the system. The total came to about $1530 (allowing for some variation in retail prices). If we subtract this amount from the retail price of the Osborne 1, the computer hardware itself would cost only $265—not bad for a Z80 with 64K bytes of memory, two 5¼-inch disk drives, printer and modem ports, and a built-in 5-inch video display. Of course the software is being distributed for much less than normal retail prices, but in a way you are getting a software package with a computer thrown in for (almost) free.

Hardware

The Osborne 1 is approximately 9 inches high, 20.5 inches wide, and 13 inches deep. The case is weatherproof when closed and can fit under an airline seat. The power cord can be stored in the case with a plastic panel with velcro strips, which also covers the power switch and the red circuit breaker. The unit operates at 120 volts (V) AC and 50 or 60 Hz (three-wire grounded plug) and draws about 37 watts (W). It can be set to operate at 230 V AC by changing an internal jumper. The unit is convection cooled, so there is no built-in fan.

Photo 1: *The Osborne 1 personal computer.*

A 69-key detachable keyboard with 12-key numeric keypad (all with sloping key tops) is standard. The software supports full key-rollover operation.

Two 5¼-inch floppy-disk drives mounted on either side of the display screen each provide 102,400 bytes of secondary storage.

The processor board uses the Z80A microprocessor operating at 4 MHz. Main memory consists of 60K bytes of user-programmable memory and 4K bytes of ROM (read-only memory), which are bank switched. Bank switching gives the maximum use of the address space to the user by allowing physically separate memory areas to occupy the same logical address space. Memory-access time is 250 nanoseconds.

About the Author

Mark Dahmke is a Consulting Editor for BYTE and Popular Computing.

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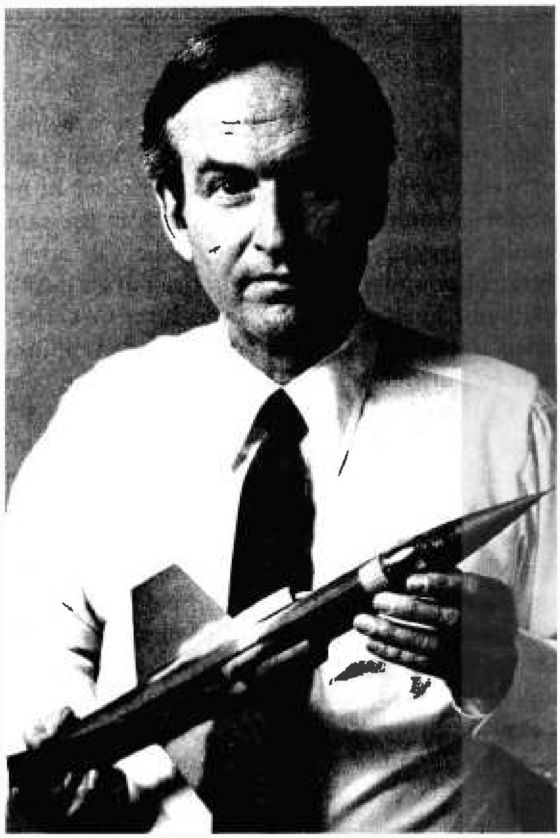

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At a Glance

Name
Osborne 1

Manufacturer
Osborne Computer Corporation
26500 Corporate Ave.
Hayward, CA 94545
(415) 887-8080

Hardware
Z80A microprocessor running at 4 MHz; 64K bytes of main memory; 4K-byte video display organized as 32 lines of 128 characters each; white on black display, 52 characters by 24 lines visible with scrolling screen to view remainder of display; built-in 5-inch video monitor; half- or full-intensity video with optional underlining; 96-character ASCII set with 32 graphics characters; dual 100K-byte, 5¼-inch disk drives; 69-key keyboard with numeric keypad and four-direction arrow keys; serial RS-232C interface with separate modem connector (modem adapter allows simultaneous use of modem and printer); and IEEE-488 interface

Software
60K CP/M 2.2 (operating system), Wordstar with Mailmerge, Supercalc, CBASIC, MBASIC, XDIR (extended directory display), Help (system help file), FMT (disk formatter program), Copy (disk copy program), Setup (system configuration program), CP/M standard utilities (i.e., PIP, SYSGEN, MOVCPM, ASM, DDT, Dump, Load, Submit, and XSUB)

Options
External video, battery adapter, double-density disk drives, 80-column display

Price
$1795

Warranty
90-day limited

Audience
Anyone who needs a complete business computer system or a portable computer at a reasonable price

A recent ad for the Osborne 1 shows a man carrying a briefcase and another carrying an Osborne 1. While I can see many reasons for carrying along a computer in my work, I doubt I would carry an Osborne 1 in the same way I would carry a briefcase. First, the Osborne 1 weighs about 24 pounds, which would tire out all but the most athletic of travelers. Second, though the Osborne 1 was designed to fit under an airline seat, I don't think I would want to put one there. In fact, some of the commuter flights I have taken won't allow anything that size to be carried on, and the thought of checking my computer as baggage makes me a bit nervous. Remember, inside that rugged-looking package is a small video monitor and two disk drives, all of which are vulnerable to sudden shocks. Cathode ray tubes have been known to implode from less stress than a two-foot drop onto concrete. Also, disk drives can be thrown out of alignment fairly easily. The Osborne 1 would be portable enough for many people, provided sufficient care is taken to avoid bouncing it around.

The Osborne 1 comes with two single-density disk

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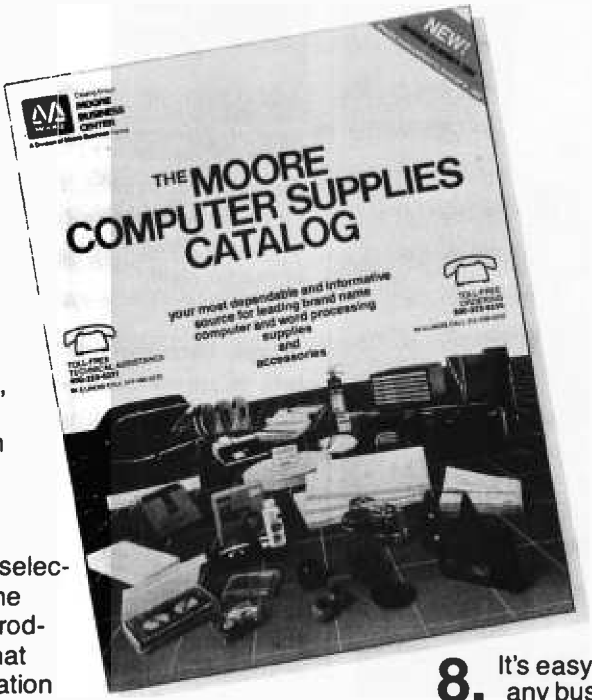

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Photo 2: *The keyboard of the Osborne 1. The four arrow keys on the upper right next to the Return key can be configured for use with CP/M or Wordstar, but not both. Numeric keypad is at the far right.*

drives, each capable of storing 102,400 bytes or characters of information on a single 5¼-inch floppy disk. A double-density option is also available, allowing the Osborne 1 to store as much as 204,800 bytes or characters per disk. According to the user's manual, data is physically stored on each disk as 40 tracks, each track divided into 10 sectors (soft-sectored). Each sector contains 256 bytes of data. This works out to 100K bytes, which matches the 102,400-bytes-per-disk figure mentioned in the manual. Tracks 0, 1, and 2 contain the CP/M 2.2 operating system. On track 2, sectors 3 through 6 hold the customized BIOS (basic input/output system), sectors 7 and 8 hold the initial screen display (the Osborne logo), and sector 9 holds information such as the serial number and some system test procedures. Thus, about 92.5K bytes remain for user storage.

While I can see many reasons for carrying along a computer in my work, I doubt I would carry an Osborne 1 in the same way I would carry a briefcase.

The video display of the Osborne 1 has some unique features and some problems. The "real" display window provides 32 lines of 128 characters per line. To accommodate the small video monitor (5 inches diagonally), however, only 24 lines of 52 characters each can be seen at any one time. The user may scroll the screen both horizontally and vertically to look at any 24-line by 52-character portion of the total display window. Scrolling is accomplished by holding down the control key while simultaneously using one of the four arrow keys. The display doesn't jump as one would expect but instead scrolls smoothly causing no eyestrain.

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EPSON MX-80

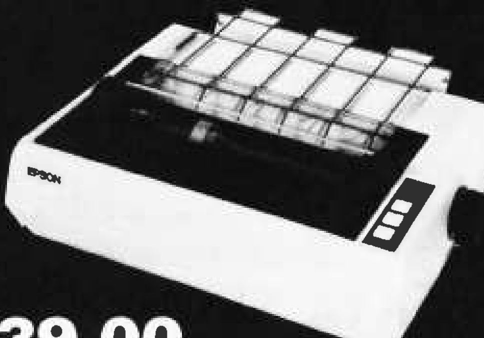

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Photo 3: *Front view of the Osborne 1. The 5-inch diagonal video display is seen at center, and the 5¼-inch disk drives are on either side of the display. Storage space for disks is provided below the two disk drives. RS-232C, IEEE-488, and modem cable connectors are in the lower left. An insulated ribbon cable connects the keyboard to the rest of the computer just below the video display. Brightness and contrast controls and external video connectors are found up front. The reset switch is also up front but is not likely to be pressed accidentally because of its location. The last connector is for the external battery pack.*

Surprisingly, the size of the display doesn't cause eyestrain either. I asked a friend with bifocals to try it, and he claimed he wasn't bothered by staring at the small screen. This is interesting because if you stand 3 feet away from the screen, it is almost unreadable. But if you sit at the keyboard with the screen about 15 inches away, it is quite clear.

Characters on the display screen are formed in an 8 by 10 dot matrix. The character generator holds 128 character shapes, and a standard 96-character ASCII (American Standard Code for Information Interchange) set is provided, plus an additional 32-character graphics set. Unlike many personal computers, the character set cannot be changed by the user. The display does allow for underlining and half-intensity display of individual characters on the screen.

The keyboard of the Osborne 1 is detachable. In fact, there is no way it can be attached, except when the unit is closed up. After it is unlatched from the computer cabinet, all that connects it to the computer is a flat, insulated ribbon cable. Although the connector looks like it is ready to break off, it is quite solid.

Keyboard decoding is done on the main circuit card, so no complex circuitry is present in the keyboard housing itself. The hardware supports full key-rollover operation, meaning that no matter how fast you type, the computer can keep up with you. The only characters missing from the keyboard are { } ¯ ` and DEL. However, these can be entered by depressing the control key simultaneously with . , / = and ?, respectively. These keys are not that important except, perhaps, for programming in certain high-level languages such as Pascal. Also, the backspace function is provided by the Left Arrow key. Since the ar-

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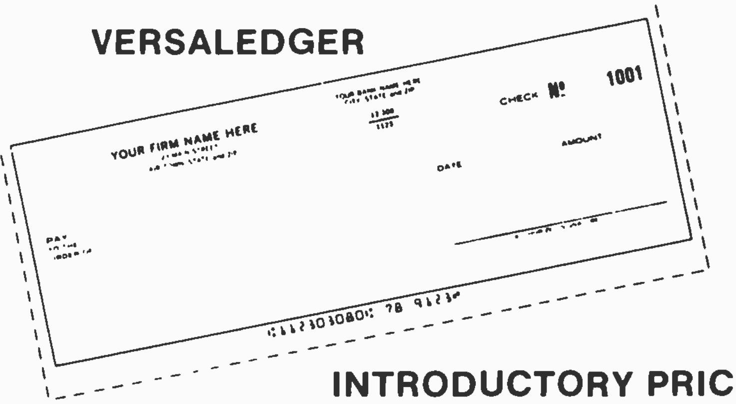

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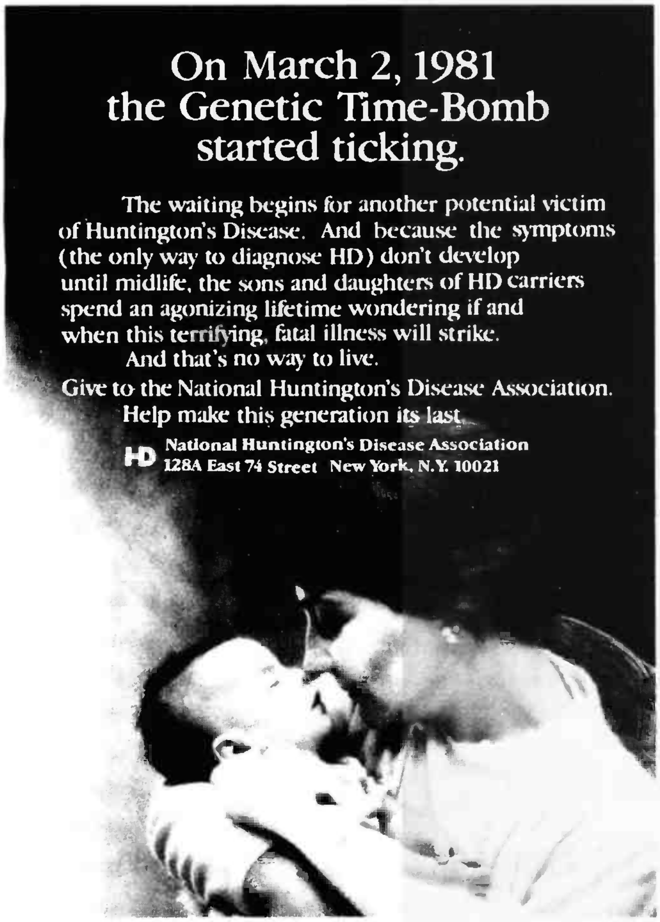

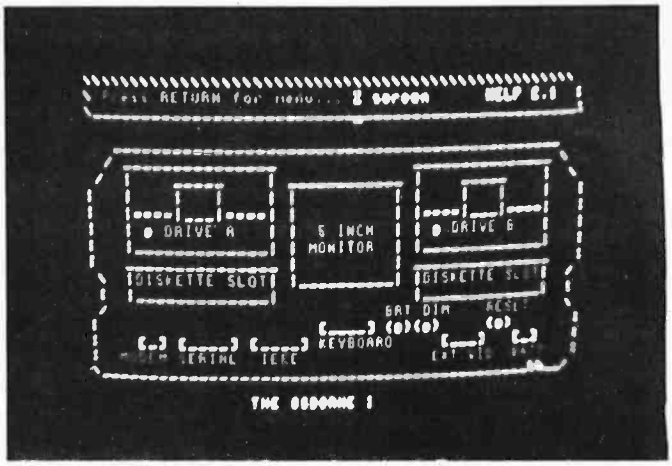

Photo 4: *The Osborne 1 video display is arranged as 32 lines of 128 characters per line, but only 24 lines of 52 characters can actually be seen at one time with the built-in display. The four arrow keys (when used in conjunction with the control key) can be used to scroll horizontally and vertically.*

row keys (cursor controls) cannot be set up for use in CP/M and Wordstar simultaneously, the user must choose one or the other configuration. If Osborne had simply defined the arrow keys to work in Wordstar (where they are much more useful), then a separate backspace key could have been assigned for CP/M. Considering how many products have been ruined by poor keyboard layouts, I find it difficult to understand why a few keys were left off an otherwise excellent design.

The Osborne 1 comes complete with an RS-232C connector and a separate modem connector. You need a separate interface box to use a standard modem when it is connected to the modem connector. It is important to note, however, that if you want to use a modem by itself, you can connect it directly to the RS-232C port and eliminate the need for the interface box. Therefore, the only limitation is that you can't use a modem and a serial printer at the same time without the interface box. Apparently, a single serial interface is used to talk to both the RS-232C port and the modem.

The IEEE-488 interface has two uses. First, as the name implies, you can use it as a full IEEE-488 port with handshaking, thus allowing the use of several interesting peripherals, such as a hard disk. It may also be used as a Centronics-compatible printer port, if you purchase a cable with a Centronics-type connector at one end.

Software

The Osborne 1 comes with an impressive array of software. Included as standard are the CP/M operating system, Wordstar (with Mailmerge), Supercalc, CP/M 2.2, CBASIC, and MBASIC. Also included are several useful utility programs.

Wordstar, the popular word processor, is fully implemented on the Osborne. The only annoying feature is the scrolling of the 52-character display. If your text line becomes longer than 52 characters, the screen has to

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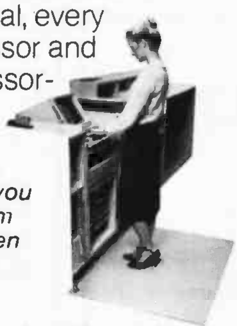

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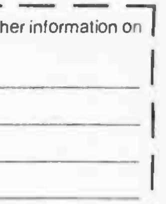

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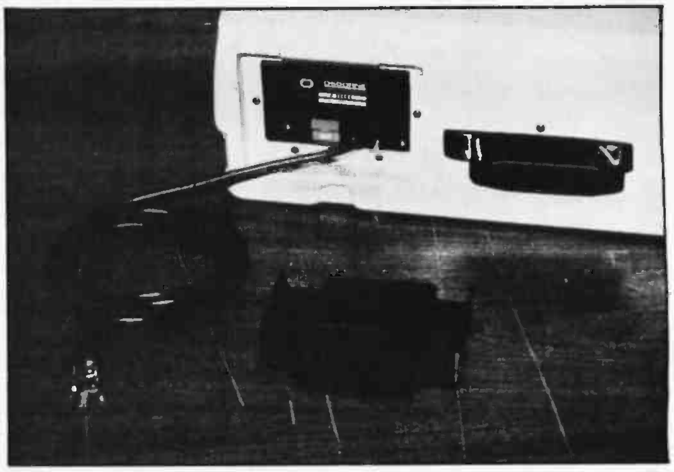

Photo 5: *The power cord, on/off switch, and circuit breaker are located on the back of the unit covered by a plastic panel with velcro strips.*

scroll horizontally. Also, you must run Setup (a utility program) and choose whether the four arrow keys on the keyboard are to work in Wordstar or in CP/M. Apparently, you can't have both. Otherwise, Wordstar operates just as it would on any other computer.

Supercalc may be the best buy on the system. Similar to Visicalc, Supercalc lets you set up electronic spread sheets for budgeting, balance sheets, or just about any columnar information.

Supercalc may be the best buy on the system.

CBASIC and MBASIC are provided so you can test BASIC programs with interpretive MBASIC, then compile them with CBASIC to run faster. Both are fairly standard versions of BASIC.

Utilities

Utilities provide the user with the basic tools necessary to manipulate the computer system and data. I found the utility called Setup, which comes with the Osborne 1, to be the most useful. It allows you to change certain characteristics of the system. For example, Osborne included a number of standard printer protocols in the BIOS. These allow the computer to communicate successfully with a variety of printers. You can choose between standard serial (no protocol), Qume (ETX, ACK), Diablo (XON, XOFF), Centronics, or PET IEEE-488. You can also change the serial-port data rate to 300 bits per second (1200 bps is the default). You may choose a different screen size—52 for a fixed screen, 128 for scrolling—or you can enter a width of your own choice, such as 80. The automatic horizontal scrolling mode can be enabled or disabled, and the four arrow keys can be set to work either in Wordstar or in CP/M.

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Photo 6: *The Osborne 1 when closed up. The handle makes it easy to carry, but the sloping keyboard (which becomes the bottom) makes it sit at an angle. It has the feel of a lightweight sewing machine.*

The keys on the numeric keypad can be programmed as function keys if you don't plan to use them to do numeric entry. The 0 through 9 keys can be redefined using Setup to any sequence of characters. For example, you could define the "0" key to be "XDIR", which would enter the extended directory display command (in CP/M).

When you make system changes with Setup, typing "X" when asked for the destination disk will return you to the CP/M level without saving the changes on disk. They will remain in effect only until you reset the system or power down. However, system changes can be stored permanently on one or more disks so the options are active the next time you boot the system with that disk.

FMT is a utility that will format a disk for use with the Osborne 1. Because the computer cannot use soft-sectored disks before they are formatted for a particular track/sector layout, you must run this program on all new disks.

The Copy utility allows you to make a complete copy of a disk for backup purposes, or just the data or user portion, or the system or CP/M portion. A separate pro-

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gram called Backup will direct you through a backup procedure to save your files.

Documentation

Many popular personal computers have such poor documentation, I am amazed the average user can make any sense of it. The Osborne 1 comes with one of the most impressive user's manuals I have seen. No doubt Adam's publishing background helped in this area. The manual begins by showing how to set up the computer and gives you a tour of all its connectors, the video display, the keyboard, and the disk drives. It then explains how to handle floppy disks and how to "boot" the CP/M operating system.

For many users, the lack of simple start-up instructions can be the first in a long series of frustrations. When the Osborne 1 is first turned on, the display tells you to insert a disk in drive A and press the Carriage Return key on the keyboard. Most other personal computer manufacturers assume the user understands this.

After CP/M is loaded from disk into memory, the display lists a menu of options such as "Just starting" and "Self portrait." Each of these menu entries gives the user a quick explanation of the hardware and software of the computer and how to use it. Even without the bound instruction manual, most users would be able to run the system after a few hours of experimenting.

Another advantage to the Osborne 1 is that all disks that come with the system have a copy of CP/M on them. Each disk is a "master." You can insert any of the disks into drive A, and the system will boot properly. While this doesn't mean that you won't have to make backups, it does mean that some of the frustration is eliminated when you first use the system. Most companies give you just one copy of the disk operating system, expecting that you will make backup copies yourself. Of the disks provided with the Osborne 1, one is a CP/M system disk and another is a CP/M utilities disk. Also included are ready-to-go disks with Wordstar, Supercalc, MBASIC, and CBASIC on them.

Conclusions

•The Osborne 1 definitely has a lot going for it. It has the best features of all the business computers, plus enough software to satisfy all but the most demanding of requirements.

•It is well designed with a rugged all-in-one enclosure, making it easy to move and set up.

•The major complaints have been the stark "military" look and the small video display (52 characters wide). Also, 5¼-inch disks hold only 100K bytes of data, just under half that of a single-density 8-inch disk.

•Apart from these limitations, the Osborne 1 comes closer to being the ideal business system for low-end applications. ■

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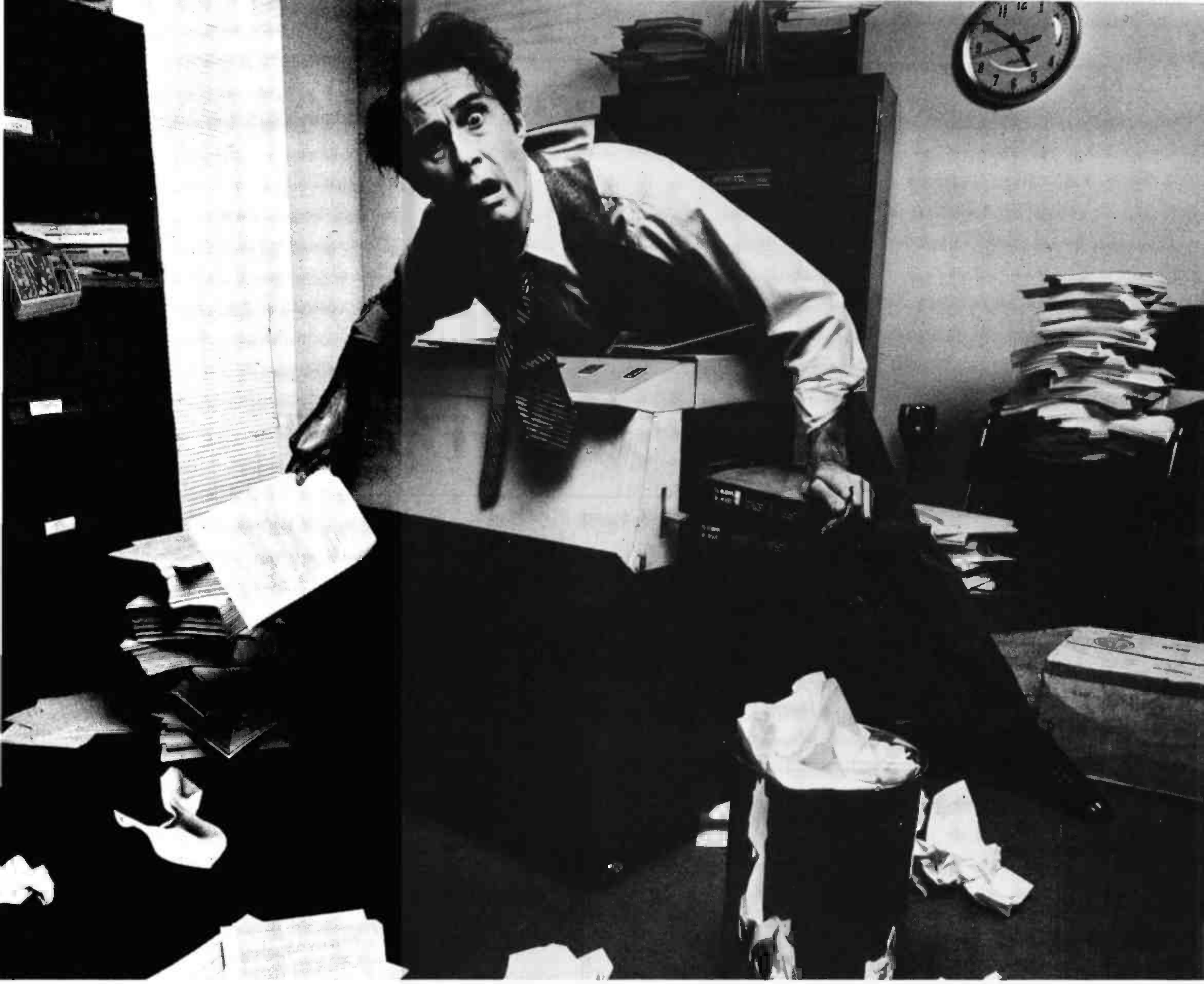

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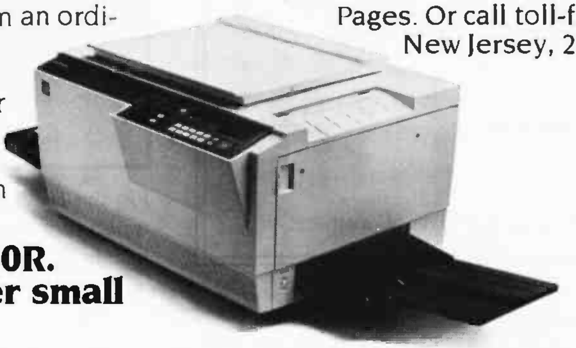

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Hardware Review

Applescope Stores Dual Traces

Gregory MacNicol
211 Maple
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Imagine an easy-to-use digital-storage oscilloscope with a computer's high-resolution video display. The Applescope, selling for $595, is just that and more. If you've ever used an oscilloscope and wanted to store the display, whether just to examine it for a few seconds or to make a permanent record, you can already appreciate the Applescope's foremost virtue. Even if you want to show timing relationships, graph slow audio-spectrum sweeps, create Fourier transforms, or smooth data, the Applescope can help.

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For those who have never used an oscilloscope, this tool will allow you to learn about digital-storage technology without great expense. Although the Applescope is geared toward the experienced amateur, the 48-page manual makes the unit easy to use.

Construction

The circuitry of the Applescope interface is simple when compared with typical digital-storage oscilloscopes on which the plethora of knobs tends to confuse the user. All functions of the device are activated through simple keyboard entries.

The Applescope consists of two printed-circuit boards (see photo 1) that separate the digital and analog circuitry to avoid noise problems. The quality of the boards is

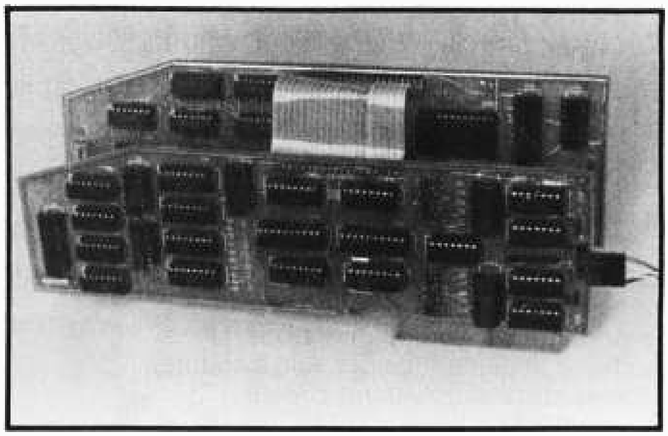

Photo 1: *Applescope's two boards. Noise is reduced by separating the analog and digital circuitry. The boards are connected by a 20-conductor flexible cable.*

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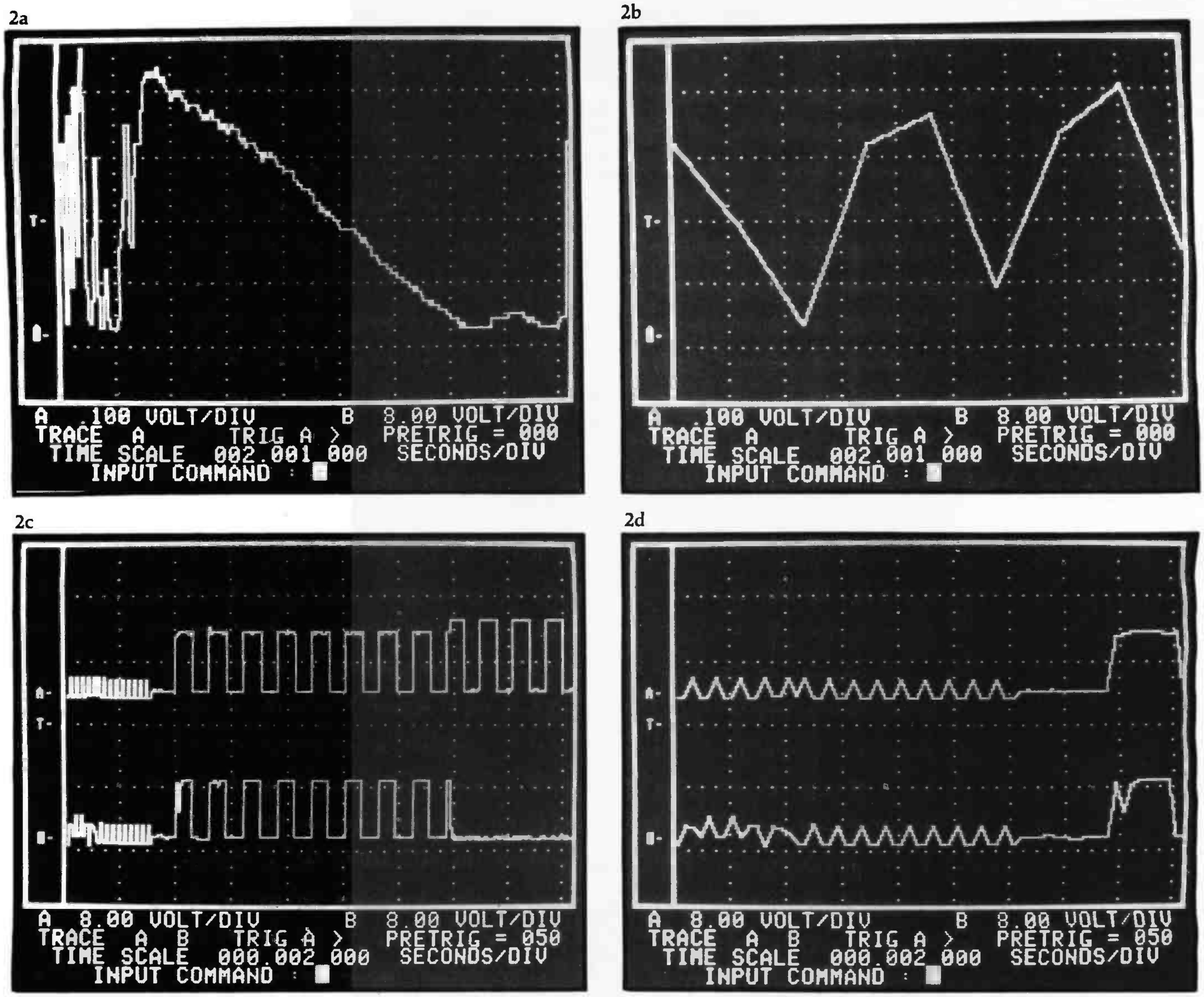

```
A  .100 VOLT/DIV        B  8.00 VOLT/DIV
TRACE  A       TRIG A >   PRETRIG = 000
  TIME SCALE  002.001 000  SECONDS/DIV
     INPUT COMMAND  : █
```

```
A  .100 VOLT/DIV        B  8.00 VOLT/DIV
TRACE  A       TRIG A >   PRETRIG = 000
  TIME SCALE  002.001 000  SECONDS/DIV
     INPUT COMMAND  : █
```

```
A  8.00 VOLT/DIV       B  8.00 VOLT/DIV
TRACE  A  B    TRIG A >   PRETRIG = 050
  TIME SCALE  000.002 000  SECONDS/DIV
     INPUT COMMAND  : █
```

```
A  8.00 VOLT/DIV       B  8.00 VOLT/DIV
TRACE  A  B    TRIG A >   PRETRIG = 050
  TIME SCALE  000.002 000  SECONDS/DIV
     INPUT COMMAND  : █
```

Photo 2: *Images produced by Applescope. Photos 2a and 2b demonstrate the expansion function: 2b is the first segment of 2a, expanded along the horizontal axis 64 times (expansion by 256 is possible). Photos 2c and 2d show a combination of the pretrigger and expansion functions: 2d is the expansion of 2c, where the pretrigger parameter was set at 50 samples. Note the three-line status display at the bottom of the screen.*

very clean and professional; all parts are labeled. All 45 integrated circuits are installed in sockets, allowing easy maintenance.

Both channel A and channel B inputs enter through a small 5-pin connector manufactured by Berg. Personally, I don't like this arrangement because probes made by most manufacturers use BNC connectors. (There is, however, a $95 option that includes two standard probes and their mating BNC connector. This is a sensible addition to the unit that both makes it easier to use and reduces input-signal noise.)

Operation

The installation procedure is easy; however, the manual provided does assume that you have prior knowledge of electronics. Setup requires that you go into the Apple II's monitor program, change the interrupt code, and execute the G (go) instruction specifying the expansion-slot location of the Applescope's digital board. The manual does not help you to distinguish between the analog and the digital board.

All instructions to the software are entered through 22 keyboard codes. They control settings for the trigger, voltage scales, time scale, sweep mode, expansion factor, and pretrigger (see photo 2). Pretrigger is a feature that allows you to view a record of the trace that occurred *before or after* the trigger point. This is great for digital troubleshooting when you wonder what happened first; for instance, it might let you find a glitch, or voltage transient, that occurred several clock cycles before a problem became obvious.

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If you were to try to design an Applescope, you would encounter two problems: size and power limitations. Laudable but invisible to the user, the ADC (analog-to-

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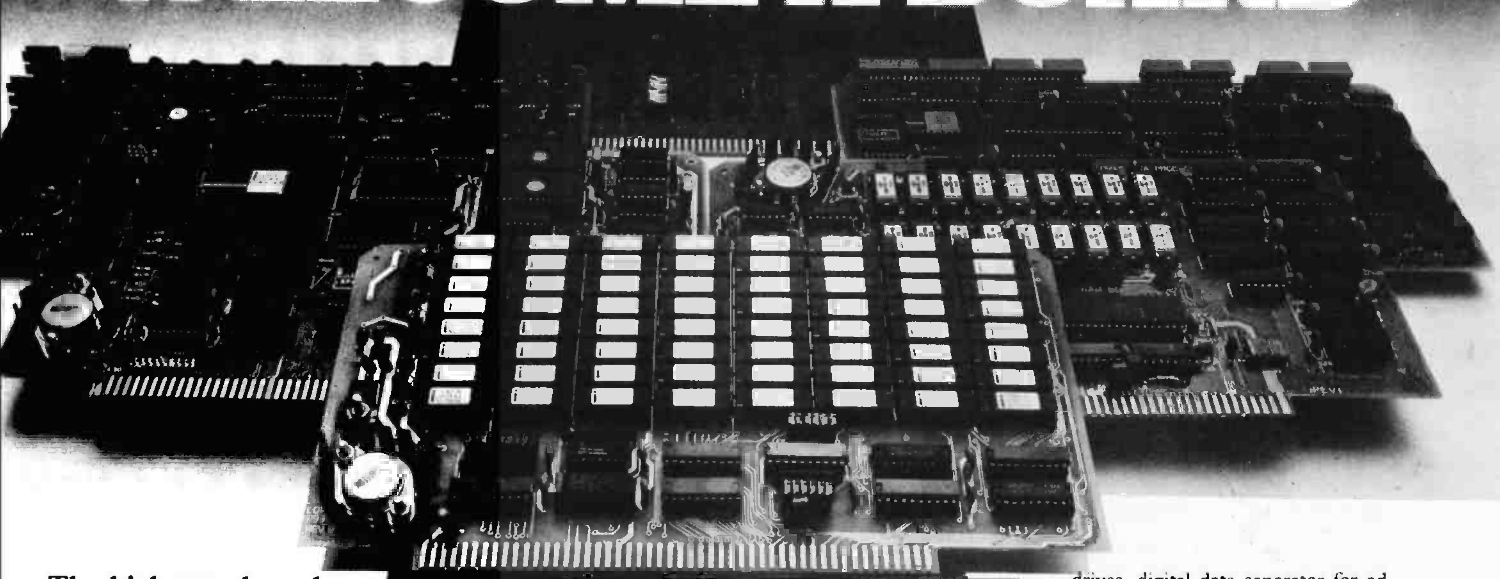

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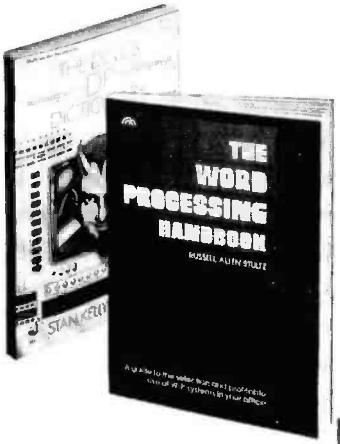

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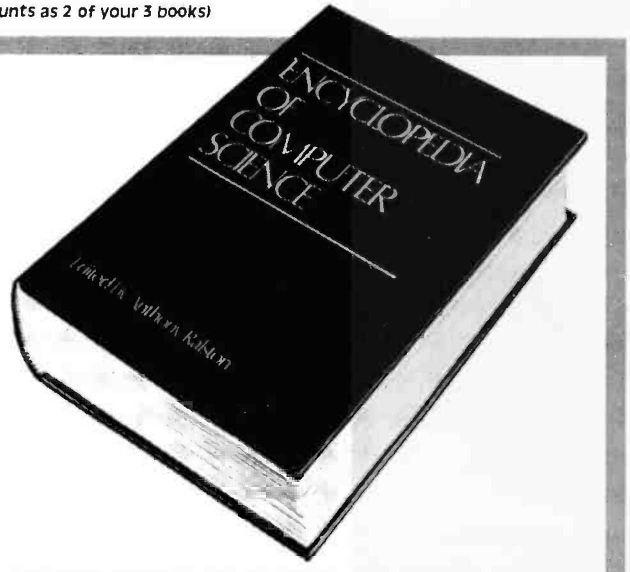

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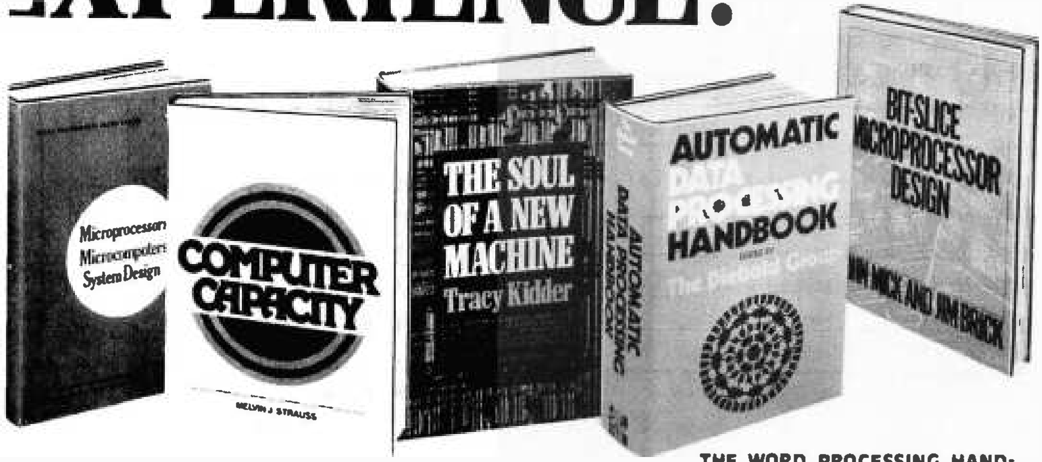

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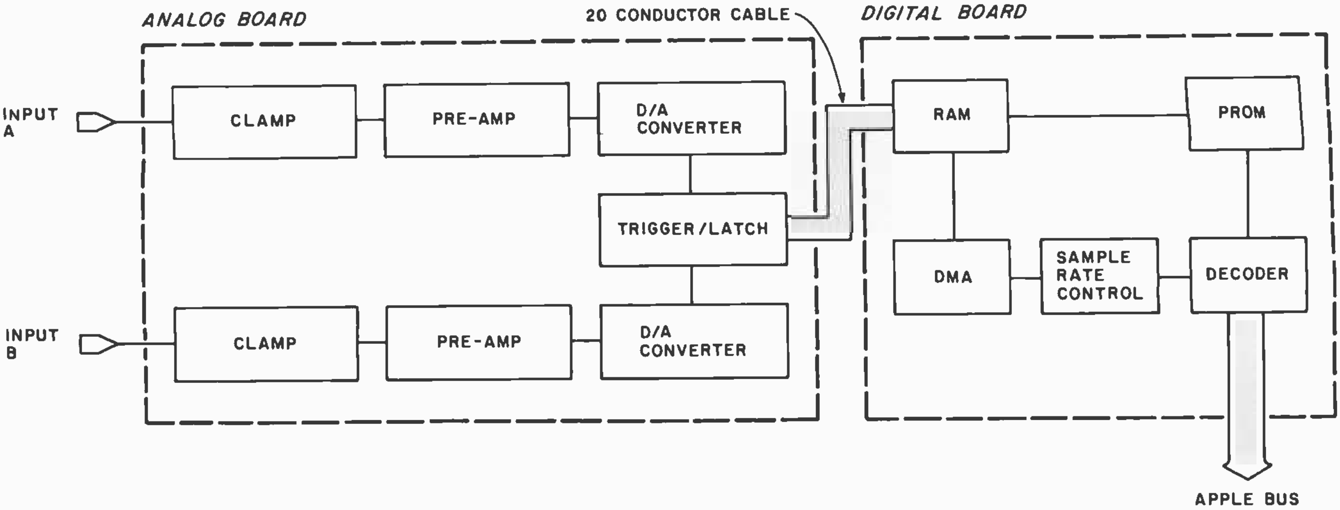


Figure 1: *Block diagram of Applescope's circuitry. The interface occupies two slots on the Apple II's expansion bus; the amplifiers and conditioning circuits for analog input signals are kept separate from the digital electronics to reduce interaction and noise.*

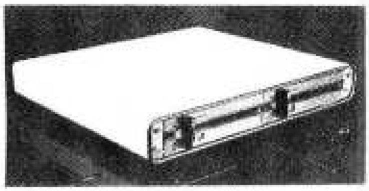
digital converter) has been carefully designed to work within the Apple II's interface requirements; otherwise, the power supply would sizzle from overuse.

The Applescope's major components are shown clearly in figure 1. All input signals are clamped to ±11.1 volts (V); the two channels are individually amplified. The analog board digitizes the processed signals through two modified tracking ADCs; 1024 samples (512 in dual-trace mode) are obtained at 0.286 microseconds per sample.

The digital board has 1K bytes of memory on-board that temporarily stores the digitized data as it comes in. This board also has the triggering logic, DMA (direct memory access) support logic, and the PROM (programmable read-only memory) that contains the Applescope's operating software.

Data is eventually transferred over the Apple II's bus in two's-complement form and is read at locations 0C00 through 0FFF hexadecimal. This data is stored on disk in its raw form. Roughly 200 milliseconds later, this information is displayed on the video monitor as an oscilloscope trace with 280- by 160-pixel (picture element) resolution. The various parameters and settings chosen are displayed at the bottom of the screen as three lines of text.

Because uses of the Applescope might vary, the designers have provided places for extra capacitors and resistors on the analog board. The idea is that additional components might be necessary in some applications to alter the response of the clamping and amplifying circuits. These vacant locations are all labeled.



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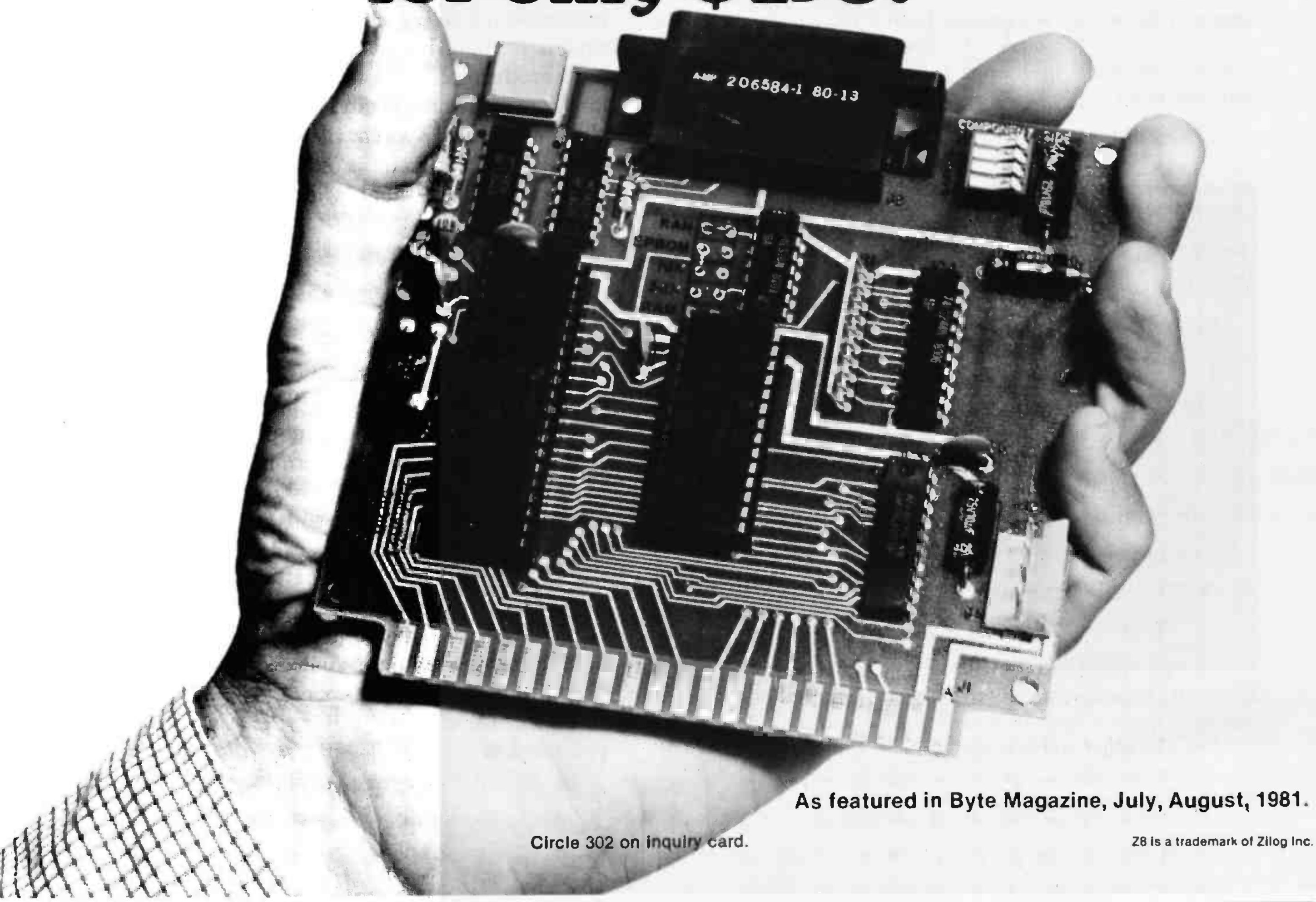

As featured in Byte Magazine, July, August, 1981.

Circle 302 on inquiry card.

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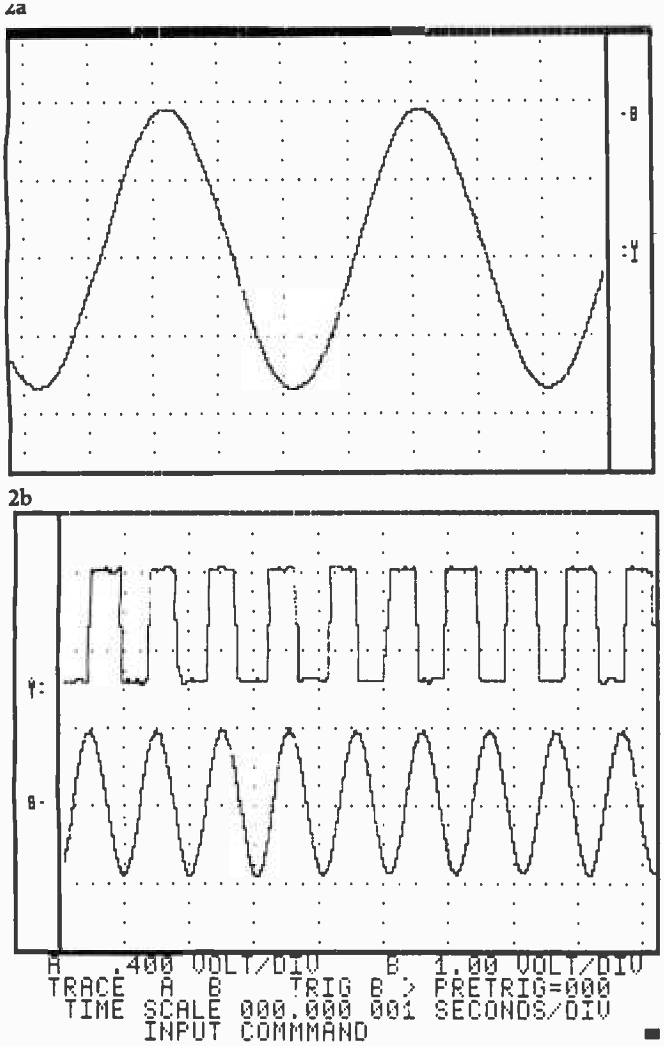
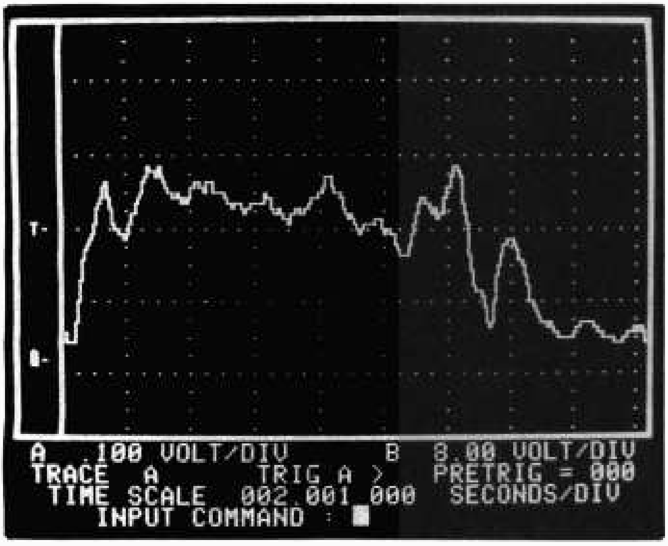


```
A   .400 VOLT/DIV      B  1.00 VOLT/DIV
TRACE   A  B     TRIG B > PRETRIG=000
 TIME SCALE 000.000 001 SECONDS/DIV
          INPUT COMMMAND
```

Figure 2: *Hard copy is available from a printer. Figure 2a is a simple sine wave that shows Applescope's resolution. Figure 2b demonstrates that Applescope suffers from neither overshoot nor crosstalk.*



```
A  .100 VOLT/DIV        B   8.00 VOLT/DIV
TRACE   A        TRIG A >   PRETRIG = 000
 TIME SCALE  002.001.000   SECONDS/DIV
      INPUT COMMAND  :
```

Photo 3: *Typical audio-spectrum plot. Information collected during the input cycle is stored on disk and may be used or modified by other Apple programs.*

Software

Remarkably, the Applescope's software is all packed into 2K bytes of EPROM (erasable programmable read-only memory). The software contains all the commands and display directives that the average user needs. There is also a disk-based software package, available for $49, that lets you do signal averaging, real-time display update, and exact voltage measurement. Provision is made for hard copy from a printer (see figure 2).

The Applescope's manufacturer, R. C. Electronics, has promised to provide customized software for specialized applications. Other companies are showing interest in this type of software. For example, W. H. Nail Company in Oroville, California, is providing physiologic-related software for educational use that includes biofeedback, heart-rate analysis, and histograms—all with hard-copy output. I can also see a need for a logarithmic package that displays signals with a decibel scale for audio work.

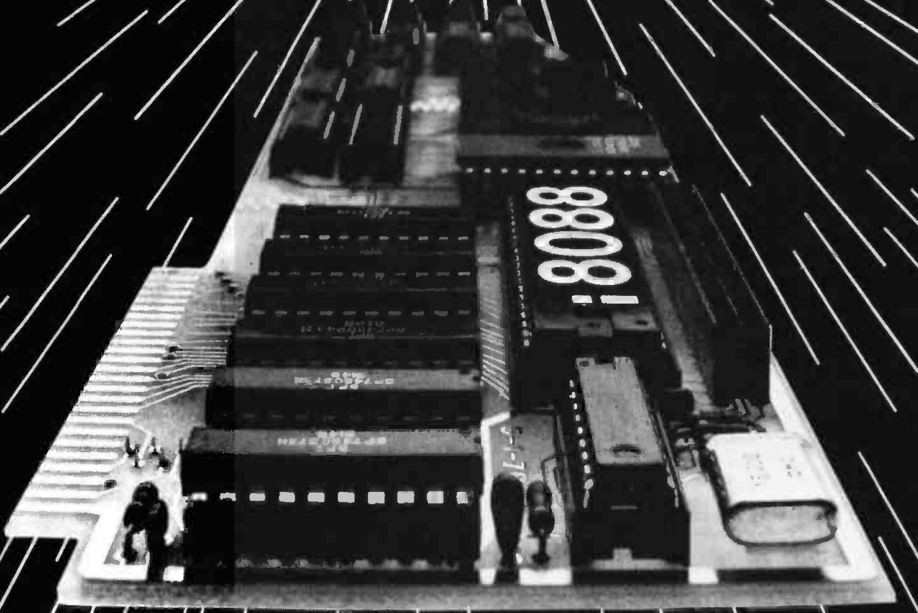
Sound Applications

Because I'm involved with speaker design, I went about applying the Applescope to create a spectrum plot of speaker-system response. Setup was a snap: I wanted a 20-Hz-to-20-kHz near-field spectrum plot as might be seen on standard audio test equipment. Normally this would mean using a Polaroid camera to photograph an oscilloscope screen while an audio generator made a 70-second sweep of the spectrum. With the Applescope (see photo 3), I simply set the time scale at eight seconds per division and triggered it and the generator. The labeled result was displayed, printed out, and put in my notebook for reference. This was easier, faster, and less expensive than the Polaroid technique.

A product of this sort has tremendous potential. So far, a mix of current and future applications might include audio and speech analysis, physiologic recording, biofeedback applications, education, chart recording and documentation of analog data, and fast Fourier transform experiments.

Conclusions

The Applescope acts like a digital-storage oscilloscope, storing information in memory and freezing the signal image on screen. It is very well designed and constructed. However, before you pull the plug on your trusty Tektronix, it is important to determine the Applescope's limitations. While it is excellent for digital signals slower than 3.5 MHz, the Applescope, like any tool, requires careful use. The images it produces can suffer from aliasing and Apple-bus noise—problems not encountered in an analog oscilloscope. (The display time is quicker with an analog oscilloscope too.) If you need fast response or work with high voltage, keep your analog oscilloscope around, but if you require graphic display of digital data or sophisticated storage of signal traces, the Applescope is the tool you need. ■



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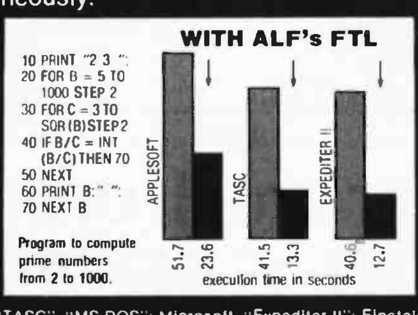

```
10 PRINT "2 3 ";
20 FOR B = 5 TO
   1000 STEP 2
30 FOR C = 3 TO
   SQR(B)STEP2
40 IF B/C = INT
   (B/C)THEN 70
50 NEXT
60 PRINT B;" ";
70 NEXT B
```

Program to compute prime numbers from 2 to 1000.

FTL is just one use for the powerful AD8088 Processor Card. There's a Multiple Event Timer (MET) for timing critical routines in your programs, with resolution to 50 μS for scientific applications. Coming soon are **MS-DOS** (the IBM Personal Computer's DOS), **CP/M-86,** and a fast 3-D high-res graphics card that connects through the AD8088's versatile expansion port.

$345 is the suggested price for the AD8088 Processor Card with FTL and MET. An Apple II with Language Card (or 16K RAM Card) and disk drive is required. See your local Apple dealer, or write for more information.

Trademarks: "Apple": Apple Computer. "TASC", "MS-DOS": Microsoft. "Expediter II": Einstein/Goodrow. "CP/M-86": Digital Research.

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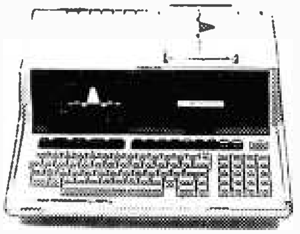

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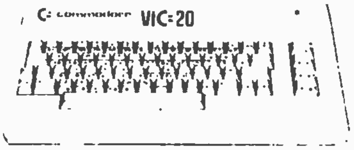

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Software Review

NEWDOS/80 Version 2.0

Mahlon G. Kelly
268 Turkey Ridge Rd.
Charlottesville, VA 22901

NEWDOS/80 Version 2.0 is the latest in a line of DOSes (disk operating systems) produced by Apparat for the Radio Shack TRS-80. The series was started with NEWDOS 2.1 so as to overcome deficiencies in Radio Shack's original DOS, TRSDOS 2.1. Since then the process of evolution and change has resulted in what may be the most powerful operating system for any microcomputer.

A disk operating system determines the whole environment within which the user works. The DOS controls not only input and output from a disk, but also all of the operating commands, the configuration of the system (disk-drive types, data density, and so on), the data-file types, various extra features in BASIC, and new editing procedures. NEWDOS/80 Version 2.0 (hereafter called V2) enhances all of those features of a DOS and provides several important utility programs as well, such as Superzap, an excellent machine-language monitor for disk files and main memory, a new disassembler, and an enhanced editor/assembler.

A disk operating system is complex. In unaltered form, V2 occupies nearly an entire 35-track disk—that's almost 90,000 bytes (although parts can be deleted to provide space on a single-drive system). The source code for the system is some 10,000 lines long. More than 800 combinations and permutations of commands, statements, and so on are possible. The user's manual is more than 260 pages long and it's lean; there's no redundancy or wordiness.

At a Glance

Name
NEWDOS/80 Version 2.0

Type
Disk operating system

Manufacturer
Apparat Inc.
440 South Tamarac Parkway
Denver, CO 80237
(303) 741-1778

Price
$149

Format
5¼-inch floppy disk

Language
Z80 machine language

Computer
TRS-80 Model I or III with disk drives

Documentation
More than 260 pages in three-ring binder

Audience
Any TRS-80 user with a need for advanced DOS

Features

V2's features are comprised of three parts: commands, enhanced BASIC language features (including new file structures), and utility programs. Commands include things like DIR, COPY, and FORMAT; i.e., instructions that are issued directly from the keyboard to the operating system but do not invoke user programs. Among the BASIC enhancements are new statements and commands, new editing features, and new file structures. Several newly modified utility programs, such as Superzap, are provided along with a variety of other attractions. For example, simultaneously pressing the "jkl" keys sends the screen contents to the printer.

Commands

The command set for V2 is summarized in table 1. Most of the commands used by TRSDOS are found there (with some exceptions like BACKUP, which is superseded by COPY). New commands have been added, and the format and function of other commands have been changed. There's not enough space to completely describe all of the commands and their differences so I'll concentrate on the most important ones; the others should be clear from table 1.

SYSTEM and PDRIVE are V2's most important commands. They provide the tremendous flexibility that is characteristic of V2. SYSTEM allows you to set up the operating environment, that is, it specifies whether an uppercase modification is installed, whether the cursor should blink, what the cursor should look like, and so on. Figure 1 shows the result of typing SYSTEM 0 with

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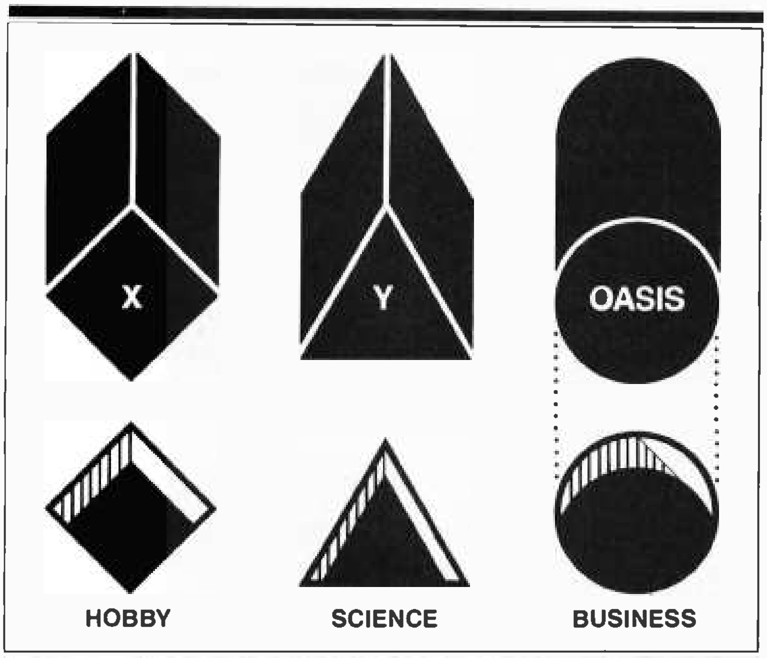

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NEWDOS/80 Version 2.0 Commands	Description
APPEND,filespec1,filespec2	Append (attach) the text of filespec2 to the end of filespec1.
ATTRIB,filespec,(options)	Change the protection status of filespec as specified by (options).
AUTO,program/CMD	Executes the program with extension /CMD immediately on "booting" or powering up the system.
BASIC2	Activate nondisk BASIC.
BLINK,(Y,N)	Enable or disable the flashing cursor.
BOOT	Reboot the system.
BREAK(Y,N)	Enable or disable the Break key.
CHAIN,file/JCL	Execute a job-control-language instruction file.
CHNON	Start or stop chaining during a job-control-language run.
CLEAR	Clear user memory and some parameters.
CLOCK,(Y,N)	Continuously show the time in the upper right-hand corner of the screen.
CLS	Clear the screen.
COPY,(options)	Perform a wide variety of file-copying functions.
CREATE,filespec,(options)	Create a new file with specified characteristics.
DATE,*nn/nn/nn*	Set or display the system date.
DEBUG	Enter the debugging monitor; also accessed by simultaneously pressing "123."
dfg	When pressed simultaneously enters a limited version of DOS.
DIR,(options)	Show a disk directory of files.
DO,file/JCL	See CHAIN.
DUMP,filespec,(options)	Dump memory to disk.
ERROR,*nn*	Show the error message for error number *n*.
FORMAT,nn,(options)	Format disk number *nn* using various options.
FORMS,(options)	Set printer page length and width (Model III).
FREE	Display free storage space on each disk drive.
HIMEM,(number)	Set the top of user memory at (number) or HIMEM alone displays the top of user memory.
jkl	When pressed simultaneously these keys will send screen contents to printer.
KILL,filespec	Remove the specified file from disk.
LC,(Y,N)	Enable or disable lowercase input (Model I).
LCDVR	Load a lowercase drive routine (Model I).
LIB	List the available commands.
LIST,filespec,*n*1,*n*2	List on the screen the contents of filespec from line *n*1 to line *n*2.
LOAD,filespec	Load a machine-language program with name filespec into memory.
MDBORT	Exit the Mini-DOS to the operating system command level.
MDCOPY,(options)	Perform a limited disk-data copy while in the Mini-DOS.
MDRET	Return from Mini-DOS to execution of a program.
PAUSE	During execution of a job-control-language task, pause and wait for the operator to press ENTER.
PDRIVE,(options)	Specify the characteristics of the disk drives.
PRINT,filespec	Same as LIST, but output goes to printer.
PROT,(options)	Set the password and user protection for a disk.
PURGE,*nn*	List the files on drive *n* and give the operator the option to delete or retain them.
R	Repeat the previously issued command.
RENAME,filespec1,TO,filespec2	Change the name of a file from filespec1 to filespec2.
ROUTE,(options)	Direct the output and input between devices (e.g., printer, keyboard, memory, RS-232C interface).
SETCOM,(options)	Set the status of the RS-232C interface (Model III).
STMT,(words)	Display a statement during execution of a job-control-language task.
SYSTEM,(options)	Specify the characteristics of the operating system and the working environment.
TIME,*nn:nn:nn*	Set or display the system time.
VERIFY,(Y/N)	Require (or don't require) that everything written to disk from memory be checked.
WRDIRP	Change the protection status of disk-directory sectors to enable cross-recognition of single-density disks between Models I and III.

Table 1: *NEWDOS/80 Version 2.0 commands. Many options give this system flexibility. The word filespec refers to a file name in the format* name/ext:n, *where* ext *is a three-letter extension and* n *is the drive number.*

my configuration. Each pair of letters is followed by a Y or N that specifies whether an option should be used or not, or each pair is followed by a number that specifies options such as the number of drives in the system. The options are summarized in table 2. Notice the great flexibility this provides and the protection that may be given to files and programs.

PDRIVE is similar to SYSTEM, but it specifies the characteristics of the system's drives. It allow great flexibility in intermixing different types of drives as well as for reading disks written on other drives. An example of PDRIVE 0 is shown in figure 2. Drive 0 is a 40-track double-density unit, while drives 1 and 2 are double-density double-sided 80-track units. In this configuration more than 1.5 megabytes of storage are available with three small floppy-disk drives.

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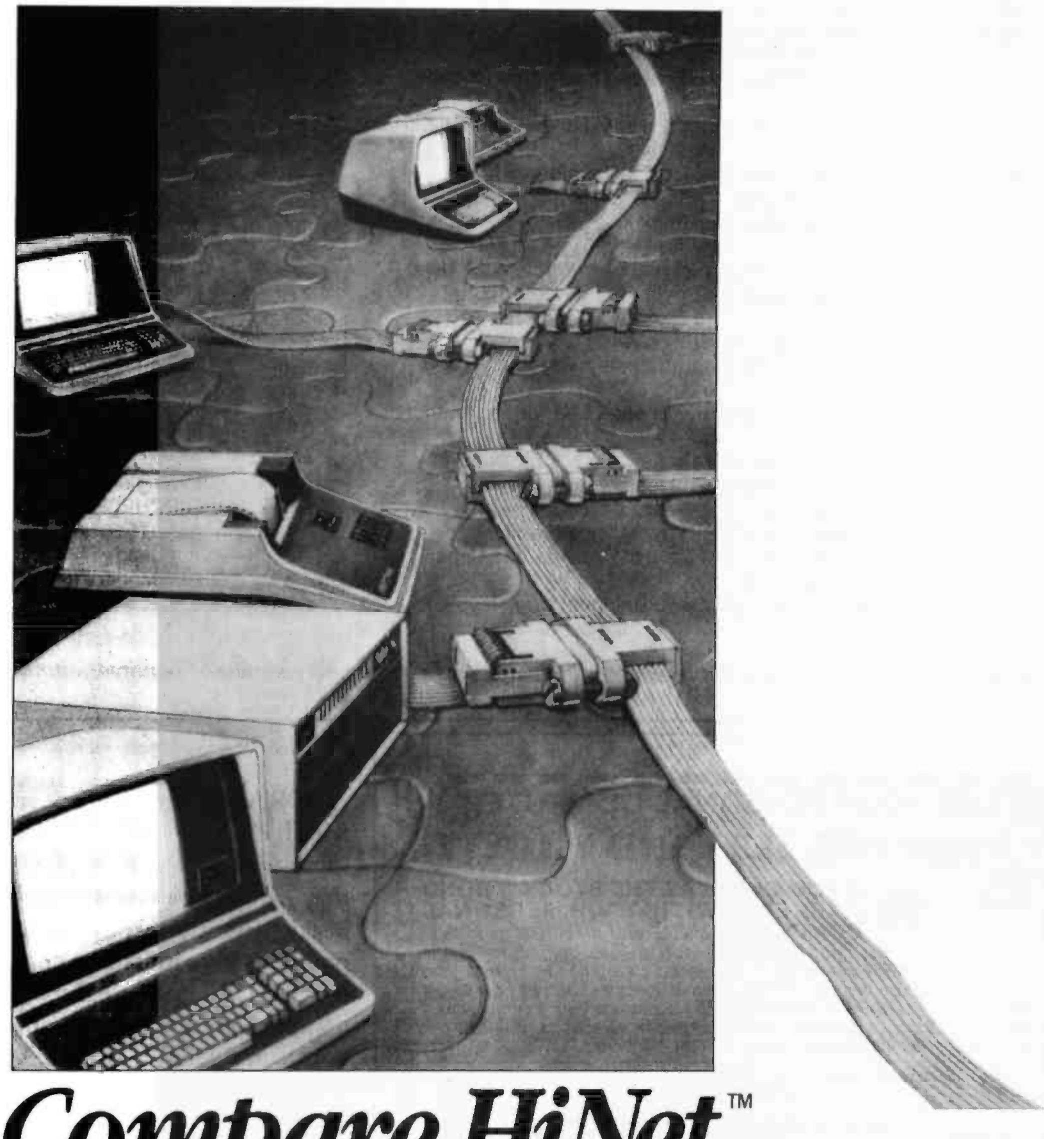

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SYSTEM Command Options	Description
AA = *yn*	enable/disable passwords.
AB = *yn*	enable/disable a run-only mode
AC = *yn*	enable/disable debounce for the Model I
AD = *yn*	enable/disable screen printing using command jkl
AE = *yn*	enable/disable DEBUG invocation with command 123
AF = *yn*	enable/disable Mini-DOS invocation with command DFG
AG = *yn*	enable/disable the Break key
AH = *yn*	not used
AI = *yn*	enable/disable uppercase or lowercase (Model I)
AJ = *yn*	enable/disable the keyboard intercept routine
AK = *yn*	not used
AL = *nn*	specify the number of drives
AM = *nn*	the number of read attempts before an error is found
AN = *nn*	specifies which drive is searched for a directory on default
AO = *nn*	default drive where a new file will be written
AP = *nn*	highest unprotected memory address
AQ = *yn*	enable/disable the Clear key
AR = *yn*	enable/disable COPY without password
AS = *yn*	change BASIC strings from lowercae to uppercase (Model I)
AT = *yn*	take single character JCL inputs from keyboard
AU = *yn*	enable/disable repeat of input when key is held down
AV = *nn*	pause before repeat of key held down
AW = *nn*	number of disk-write and verify attempts allowed
AX = *nn*	ASCII code of highest character allowed to printer
AY = *yn*	ask operator for date and time when power turned on?
AZ = *yn*	ask operator for date and time after RESET?
BA = *yn*	allow system headers after reset?
BB = *yn*	are clock interrupts at 50 or 60 microseconds (Model III)
BC = *yn*	can operator cancel or pause JCL chaining?
BD = *yn*	can operator stop AUTO execution at reset?
BE = *yn*	can the R command be used to repeat command?
BF = *yn*	enable/disable loading of lowercase driver at power-on (Model I)
BG = *yn*	enable/disable shifted uppercase mode (Model I)
BH = *yn*	should the cursor blink?
BI = *nn*	the ASCII value of the cursor character
BJ = *nn*	slow disk read/write when speed up modification is installed
BK = *yn*	enable/disable conversion between Model I and III single-density disks using WRDIRP or DIRCHECK
BL	not used
BM	not used
BN = *yn*	use Model I (N) or Model III (Y) directory address protocol for Model I single density?

Table 2: *SYSTEM command options. A yn indicates that a yes or no response is required; an nn requires a decimal number.*

PDRIVE parameters are summarized in table 3. Notice the flexibility. The parameters can be changed in the same way as the SYSTEM command's parameters and they can also be changed en bloc. In figure 2 the asterisks beside drives 0 through 2 indicate that they are actually physical drive units (the computer knows that because of the SYSTEM option AL specification). Drives 3 through 9 do not exist; those are dummy specifications. However, if you type PDRIVE 0,1=3,A, drive 1 will accept a disk written on a 35-track single-density drive (the dummy specification for drive 3). Parameter A tells the TRS-80 to make the change immediately; otherwise, you would have to reboot the system. Thus, the TRS-80 thinks that drive 1 is a 35-track single-density unit. Disks written on a Model III can be accessed in this way by a Model I and vice versa. Of course, you need a double-density modification (on a Model I) to read double-density disks, and to read 80-track disks you need 80-track drives. In other words, you can "retrogress"; you can access disks created on a less sophisticated system, but a 35-track drive cannot read 40- or 80-track disks. Another point is that 80-track drives skip a track when reading 40-track disks. Although it is possible to write 40-track disks using an 80-track drive, the result will not be reliably read by a 40-track drive. Therefore, it's not a good idea to convert all of your drives to 80-track units.

The meaning of most of the commands should be clear from table 1, but some are quite complex. For example,

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```
SYSTEM 0

AA=N,AB=N,AC=Y,AD=Y,AE=Y,AF=Y,AG=N,AI=Y,AJ=Y,AL=3/3H,AM=10/AH,AN
=1/1H,AO=1/1H,AP=0/0H,AQ=Y,AR=N,AS=Y,AT=Y,AU=Y,AV=30/1EH,AW=2/2H
,AX=90/5AH,AY=Y,AZ=N,BA=N,BC=Y,BD=Y,BE=Y,BF=N,BG=N,BH=Y,BI=127/7
FH,BJ=1/1H,BK=Y,BM=N,BN=N

NEWDOS/80 READY
```

Figure 1: *SYSTEM command display. This screen shows the result of entering the command SYSTEM 0.*

```
PDRIVE 0
0*  TI=CK,TD=E,TC=39,SPT=18,TSR=0,GPL=2,DDSL=17,DDGA=2
1*  TI=CK,TD=G,TC=79,SPT=36,TSR=0,GPL=8,DDSL=35,DDGA=6
2*  TI=CK,TD=G,TC=79,SPT=36,TSR=0,GPL=8,DDSL=35,DDGA=6
3   TI=AL,TD=A,TC=35,SPT=10,TSR=3,GPL=2,DDSL=17,DDGA=2
4   TI=CKL,TD=E,TC=39,SPT=18,TSR=3,GPL=2,DDSL=17,DDGA=2
5   TI=A,TD=A,TC=35,SPT=10,TSR=3,GPL=2,DDSL=17,DDGA=2
6   TI=CKL,TD=E,TC=39,SPT=18,TSR=3,GPL=2,DDSL=17,DDGA=2
7   TI=A,TD=C,TC=80,SPT=20,TSR=0,GPL=8,DDSL=20,DDGA=6
8   TI=A,TD=C,TC=80,SPT=20,TSR=0,GPL=4,DDSL=17,DDGA=6
9   TI=CK,TD=G,TC=79,SPT=36,TSR=0,GPL=8,DDSL=35,DDGA=6

NEWDOS/80 READY
```

Figure 2: *PDRIVE command display. This screen shows the result of entering the command PDRIVE 0.*

ATTRIB changes the protection "attributes" of a file. It has the form:

ATTRIB,filespec,(options)

The options are shown in table 4. In general, this command regulates who can access the file. I find that I have little use for this command, since all my files are open. However, I have written some teaching programs that I don't want students to see or modify. ATTRIB provides the needed security.

The CHAIN and DO commands both perform the same function. They execute a file of commands, instructions, or statements as if the instructions came from the keyboard. DO and CHAIN provide a powerful feature known as a JCL (job control language). With JCL, the computer will automatically execute a task without user input. The command file must have the suffix /JCL. The files can be written with the CHAINBLD program supplied with V2, or by using Scripsit, Electric Pencil, or other text editors.

A very simple job-control-language file, ENHBAS/JCL, is shown in listing 1. If the command AUTO DO ENHBAS or AUTO CHAIN ENHBAS has been entered beforehand, each time the system is booted the program ENHBAS/CMD, which calls an enhancement of disk BASIC, will be executed, a variety of byte values will be entered in memory, and the system will return to the DOS command level. Without prior use of the AUTO command, the same sequence will take place if you type DO ENHBAS or CHAIN ENHBAS. Some commands are used mostly from within a /JCL file: CHNON will stop the job so that input from the keyboard will be accepted; PAUSE will stop chaining, display a message, and wait for the operator to press ENTER; STMT will display a message to the screen. Otherwise, a /JCL file will use commands, statements, and so on that are recognized by

PDRIVE Command Options	Description
TI = LL	Types of drive interfaces and their specifications. A combination of letters may be used:
	A) TRS-80 standard
	B) Omikron mapper interface (Model I)
	C) Percom doubler with TRS-80 interface (Model I)
	D) Apparat disk controller (Model III)
	E) LNW interface (Model I)
	H) head settle delay?
	I) lowest sector is 1; Model III TRSDOS specifications
	J) tracks start at 1; not normally used
	K) format of track 0 density opposite to the rest of disk. Needed for system disks when using double density on Model I or single density on Model III. Model I reads the BOOT data in track 0 in single density; Model III does the opposite.
	L) two step-pulses between tracks: lets 40-track disks be read on 80-track drives
	M) disks are from Model III TRSDOS
	F-G) reserved for future use
TD = *nn*	specifies single- or double-density,single- or double-sided 5¼- or 8-inch drives
TC = *nn*	number of tracks on disk
SPT = *nn*	number of sectors per track
TSR = *nn*	rate of stepping between tracks
GPL = *nn*	granules per lump
DDSL = *nn*	specify location of directory
DDGA = *nn*	disk area allocated for directory

Table 3: *PDRIVE command options. The LL indicates that a letter must be entered.*

ATTRIB Command Options	Description
INV	makes the files invisible
VIS	makes invisible files visible
PROT = *nn*	specifies protection or access level of the file:
	7) LOCK no access allowed
	6) EXEC execute only; no reading or changes
	5) READ read and execute; no editing or changes
	4) WRITE read, execute, or change; no name changes
	3) not used
	2) NAME read, execute, change, or rename, do not delete
	1) KILL complete access, including removal
	0) FULL total and complete access
ACC = pwd	specify the password that allows access
UPD = pwd	specify the password for changing the file
ASE = *yn*	can the allocated file space be increased?
ASC = *yn*	can the allocated files space be decreased?
UDF = *yn*	mark the file as updated or not

Table 4: *ATTRIB command options. The pwd indicates that a password is required.*

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Listing 1: *A job-control-language file that first enters ENHBAS, specifies certain control parameters (the two POKES), defines the printer line width at 132, and exits BASIC to the disk operating system.*

```
ENHBAS
 POKE 16409,1
 POKE 16419,127
 CLM=132
CMD"S"
```

the system. For example, listing 1 could be followed with instructions to reenter BASIC, load a program, execute the program, make certain entries, and turn operation over to the user. This is useful for teaching programs where the student should not have to remember all of the details for initializing a program. In general, nearly anything that can be executed from the keyboard can be executed from a /JCL file.

COPY is V2's most complex command. It can be used to copy single files, several files from one disk to another, or everything on a disk. It also incorporates the function of formatting disks and it replaces the BACKUP function in TRSDOS and other systems. Additionally, COPY has a number of options that allow various types of drives to be used and allow copying on a single drive. It will be the first command you will use because it must be drawn on to produce copies of the source disk. COPY has six different formats. The simplest is:

```
COPY FILE1/FIL:1 TO FILE2/FIL:2
```

which will copy FILE1/FIL from drive 1 to FILE2/FIL on drive 2. An example of the general format for copying several files or a whole disk from one drive to another is:

```
COPY 1 TO 2,date,(options)
```

The date can be left out (the commas must remain), in which case the present date is put on the new disk. The option FMT will format the disk and produce a complete backup from drive 1 to drive 2; CBF will specify that the files be copied one by one; NFMT will not format the disk first. There are several other important options. For example, CFWD lets the user specify which files will be copied.

Disks from "foreign" systems can be copied, and, if you buy a Model III with the intention of transferring files from an old Model I system, the COPY command will do the job. If you have a more sophisticated system, say double-density double-sided drives and so on, your first use of COPY to backup the V2 disk could be difficult. Careful reading of the manual and use of the examples, however, will make it possible.

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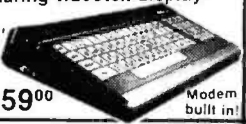

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Listing 2: *NEWDOS/80 Version 2.0 directory. If the command DIR S, I, A, P is entered, the following information is provided: file name, number of full sectors, number of bytes in the last sector, the logical record length, number of logical records in the file, number of granules, and the number of extensions used.*

```
DRIVE   0  NEWDOS80  08/04/81    35 TRKS    29 FDES      1 GRANS

                      EOF    LRL    RECS GRANS  EXTS  SIUEC....UAL
BOOT/SYS             5/000   256       5     1     1  SI.......UA6
SYS6/SYS            35/000   256      35     7     1  SIU......UA7
SYS14/SYS            5/000   256       5     1     1  SIU......UA7
BASIC/CMD           18/000   256      18     4     1  .IU......U.6
DIR/SYS             10/000   256      10     2     1  SI.......UA5
SYS7/SYS             5/000   256       5     1     1  SIU......UA7
SYS15/SYS            5/000   256       5     1     1  SIU......UA7
NWD80V2/XLF          2/054   256       3     1     1  ..U........0
SYS0/SYS            15/000   256      15     3     1  SIU......UA7
SYS8/SYS             5/000   256       5     1     1  SIU......UA7
SYS16/SYS            5/000   256       5     1     1  SIU......UA7
CHAINTST/JCL         1/050   256       2     1     1  ..U........0
NWD80V2/ILF          2/002   256       3     1     1  ..U........0
SYS1/SYS             5/000   256       5     1     1  SIU......UA7
SYS9/SYS             5/000   256       5     1     1  SIU......UA7
SYS17/SYS            5/000   256       5     1     1  SIU......UA7
ASPOOL/MAS          10/000   256      10     2     1  ..U........0
CHAINBLD/BAS        19/059   256      20     4     1  ..U........0
SYS2/SYS             5/000   256       5     1     1  SIU......UA7
SYS10/SYS            5/000   256       5     1     1  SIU......UA7
SYS18/SYS            5/000   256       5     1     1  SIU......UA7
LMOFFSET/CMD        10/000   256      10     2     1  ..U........0
SYS3/SYS             5/000   256       5     1     1  SIU......UA7
SYS11/SYS            5/000   256       5     1     1  SIU......UA7
SYS19/SYS            5/000   256       5     1     1  SIU......UA7
SYS4/SYS             5/000   256       5     1     1  SIU......UA7
SYS12/SYS            5/000   256       5     1     1  SIU......UA7
SYS20/SYS            5/000   256       5     1     1  SIU......UA7
DISASSEM/CMD        25/000   256      25     5     1  ..U........0
DIRCHECK/CMD        15/000   256      15     3     1  ..U........0
EDTASM/CMD          35/000   256      35     7     1  ..U........0
SYS5/SYS             5/000   256       5     1     1  SIU......UA7
SYS13/SYS            5/000   256       5     1     1  SIU......UA7
SYS21/SYS            5/000   256       5     1     1  SIU......UA7
SUPERZAP/CMD        30/000   256      30     6     1  ..U........0
```

Listing 3: *A short program to demonstrate the generation of a cross-reference table using the command REF$.*

```
10     LPRINT "THIS IS A PROGRAM"
20     GOTO 2000
500    FOR I=1 TO 2
510    FOR J=1 TO 5
520    IJ=I*J
530    A$="SIN OF"
540    LPRINT AS;IJ;" = ";SIN(IJ)
550    NEXT J
560    NEXT I
570    RETURN
2000   LPRINT "TO DEMONSTRATE"
2010   LPRINT "EDITING ENHANCEMENTS"
2020   LPRINT "IN NEWDOS/80 VERSION 2.0": LPRINT" "
2030   GOSUB 500
2040   END

REF $
    1   500 510
    2   500
    5   510
  500   2030
 2000   20
   A    530/$ 540/$
   I    500 520 560
   IJ   520 540/2
   J    510 520 550

RUN

THIS IS A PROGRAM
TO DEMONSTRATE
EDITING ENHANCEMENTS
IN NEWDOS/80 VERSION 2.0

SIN OF 1  =  .841471
SIN OF 2  =  .909298
SIN OF 3  =  .14112
SIN OF 4  = -.756802
SIN OF 5  = -.958924
SIN OF 2  =  .909298
SIN OF 4  = -.756802
SIN OF 6  = -.279416
SIN OF 8  =  .989358
SIN OF 10 .= -.544021
```

an empty, blank file, but with specified attributes and length. Generally it has the form:

CREATE,filespec,(options)

where the options control the record count for the file, the record length, specify whether the file length can be automatically extended, and whether unused file length can be cleared. Sometimes a user program expects a file to exist already or requires pre-allocated file space; CREATE allows that possibility.

The DEBUG command enters the system's debugging and monitor utility. Suffice to say, the original TRSDOS DEBUG has been praised by reviewers as an excellent piece of software, and Apparat's version is much better. One brief point, DEBUG can be entered from within a program by simultaneously typing "123."

DIR, available in all operating systems for the TRS-80, displays a directory of the files on a specified disk. For V2, it's been greatly enhanced. Listing 2 shows the directory for the V2 source disk using the command:

DIR 0,S,I,A,P

where 0 is the drive number, S displays the system files, I specifies "invisible" files, A asks for various specifications on each file (without A, the listing would show only the names), and P sends the output to the printer. I could have added U, which would have shown only those files that had been updated, and /CMD (or some other extension), which would have displayed only those files with the specified extension. Listing 3 gives the following information: the file name, the number of full sectors in the file and the number of bytes in the last sector (e.g., 12/123), the logical record length used for the file, the number of logical records in the file, the number of granules (a granule is five sectors and is used to allocate file space), and the number of extensions used.

In listing 3, eight flags describe the file, as shown at the end of each file entry. These flags explain whether the file is a system (S) or invisible (I) file, if it's been updated (U), whether it can be allocated more space (E for no), whether space beyond the end of file can be cleared (C for no), whether it has an update password (U) or access password (A), and the protection level (L, specified as a number).

The DUMP command simply writes a memory block to disk with a specified file name, start and end address, and an entry address (if it is a program). New to V2, DUMP allows the load locations for machine-language code to be changed. One important feature is that problematic main memory contents can be dumped to disk and later examined and modified as if the code were in memory by using Superzap's DMDB (display memory dump block) feature.

V2's FORMAT command is more powerful than similar commands in other TRS-80 operating systems. It allows many of the options of the COPY command and it

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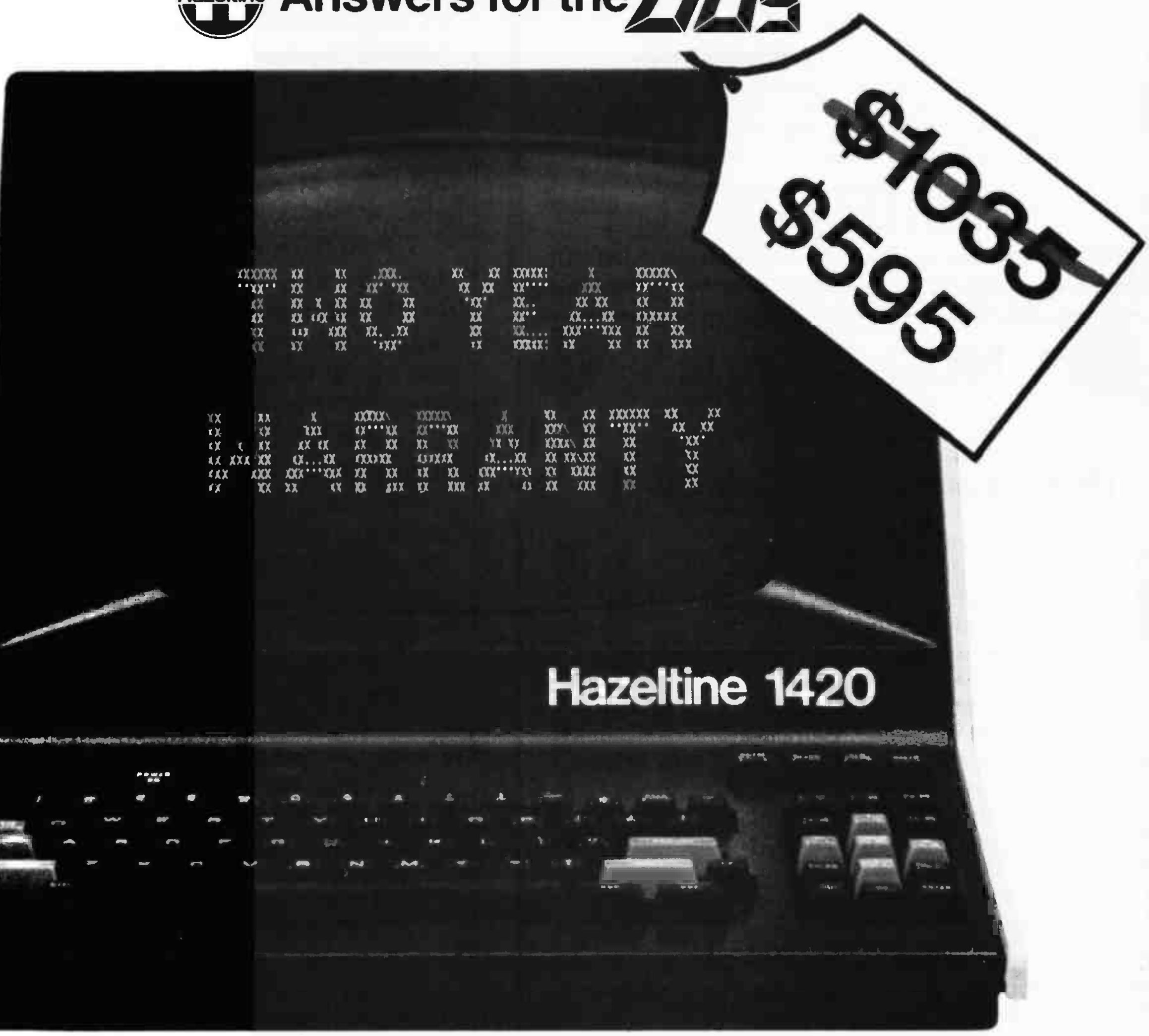

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lets you specify whether only certain tracks are to be formatted. Also, it will accept default values for the disk name, password, and date. For example:

```
FORMAT 1,,,,Y
```

assigns to the disk the name NOTNAMED, the current date, and the password PASSWORD. Y tells the computer to format the disk even if data is already there.

The commands MDRET, MDBORT, and MDCOPY use a Mini-DOS that's entered by simultaneously pressing the "dfg" keys. If this is done while a program is executing (interrupts must be enabled), a subset of the system commands may be issued. You can return to the execution of the program by typing MDRET (Mini-DOS-Return) or exit to the command level by typing MDBORT (Mini-DOS-aBORT). For example, I wrote this article using Scripsit. While writing, I wanted to see the directory. I pressed "dfg" and saw the MINI-DOS READY prompt. I then typed DIR and saw the directory. I could have killed a file if I so wished. When I typed MDRET, I returned to the Scripsit program. If I wanted to exit the Scripsit program, I would have typed MDBORT. The Mini-DOS will not work with a few of the commands, such as FORMAT, but it works with most. The MDCOPY command allows a limited version of COPY from Mini-DOS.

The ROUTE command directs input and output between devices. It's best understood from some examples. In the following discussion, DO refers to video-display output, PR is printer output, RO is RS-232C output (on the Model III only), RI is RS-232C input (only on the Model III), and KB is keyboard input. Thus, ROUTE, PR,DO will "route" printer output to the screen. (This is useful if you don't have a printer and want to use programs that expect one.) ROUTE,PR,DO,PR will send output to both the screen and printer. On the Model III, ROUTE,KB,RI allows keyboard input from the RS-232C interface, while ROUTE,DO,RO would send screen output to the RS-232C. In addition, you can "route" to a machine-language routine in memory, but, unfortunately, you cannot "route" to a disk file. ROUTE,CLEAR clears everything back to the original state.

The last command, WRDIRP, is used for exchanging single-density disks between Model I and Model III machines. I'll describe it later in this article.

BASIC Language Enhancements

V2 BASIC in the TRS-80 uses memory overlays; i.e., when certain functions are called from a program, the necessary code is read from disk and "overlaid" into memory. The disk drives may turn on even when there is no input or output, allowing V2 to expand BASIC without using extra memory.

V2's most important BASIC enhancement is the statement CMD*"xxx"* (also implemented in earlier versions of NEWDOS). The *"xxx"* option can be almost any system command. When this statement is encountered, the com-

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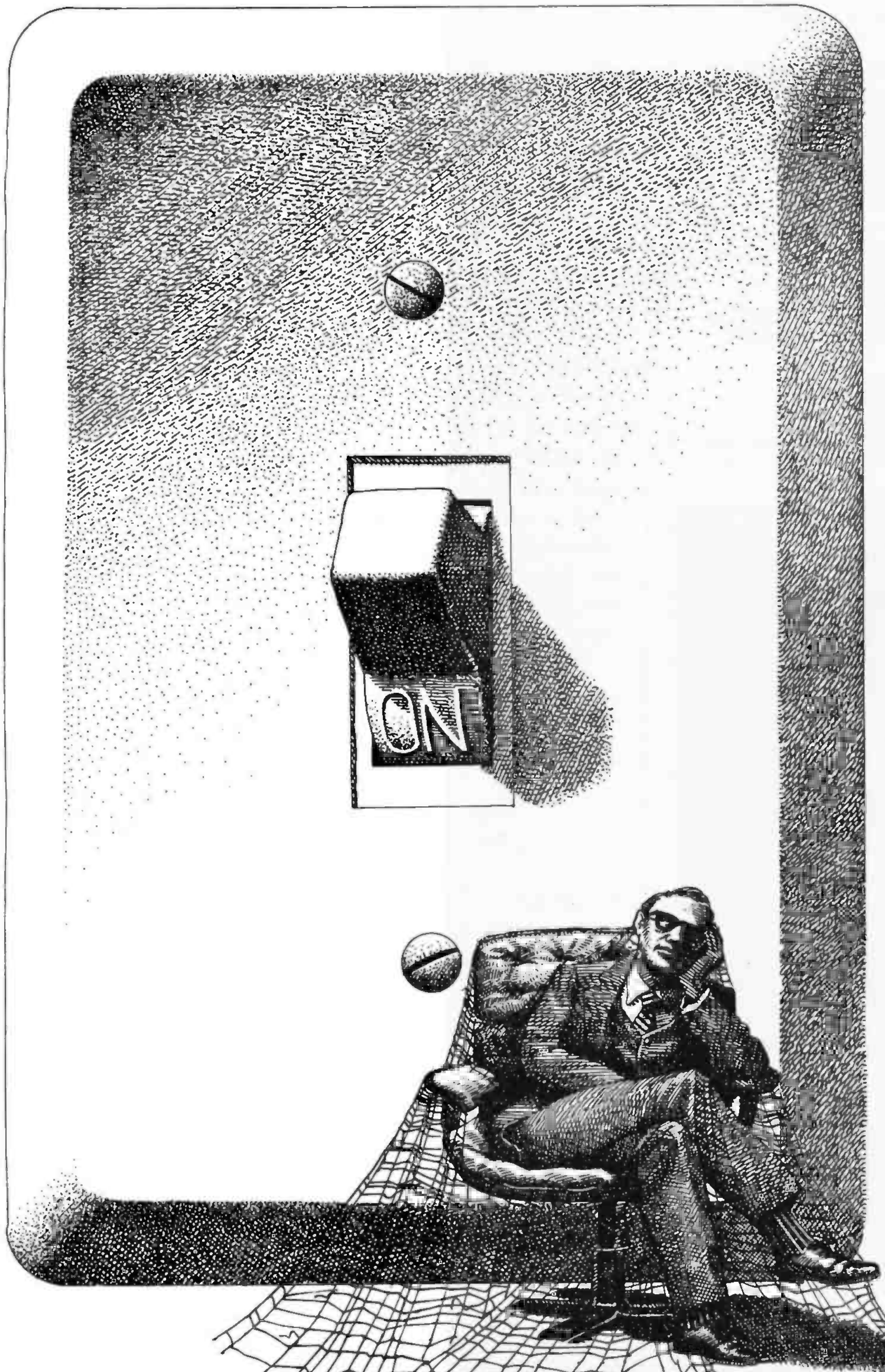

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mand is executed and operation is returned to the BASIC program. If the program includes the line:

```
200 CMD"DIR"
```

a directory will appear on the screen and then execution will be returned to the program. CMD also calls functions that are unique to BASIC. It can be used either from within a program or from the keyboard. From within a program, it allows language enhancements using the forms CMD"F" and CMD"O." The first of these has the format:

```
ln CMD"F=function"
```

where ln is a line number and "function" determines what happens.

Briefly, the CMD functions, POPS, POPR, and POPN, allow a variety of options in exiting FOR . . . NEXT loops. For example, they permit exiting a loop before its limit is exceeded or stopping the loop "early," ignoring the NEXT statement. The SASZ option lets you change the memory area allocated to string variables without affecting or clearing the variables; i.e., it clears string space without really executing a CLEAR. When followed by a variety of variables, ERASE clears the specified variables to zero. KEEP does the opposite; it clears all variables except the specified ones. SWAP, followed by two variables, exchanges the values of the variables. SS executes a program step by step, which provides a much more sophisticated form of debugging. In operation, SS displays the current line number. With SS, the line number where single-stepping should be started can be specified, and single-stepping can be stopped by using the suffix N.

CMD"F",DELETE ln1−ln2 will delete the program code between line numbers ln1 and ln2, which lets you remove a subroutine from memory and bring in another subroutine from disk. For example:

```
1000  CMD"F",DELETE 25000-30000
1010  MERGE "NEWSUB/BAS"
```

would delete the specified lines and bring in a new subroutine named NEWSUB/BAS (which must be between lines 25000 and 30000). (Note that the MERGE function no longer requires that the new code be stored in ASCII format.) This is potentially very powerful; for example, a menu could be used to select different subroutines to be loaded at different times during execution of a program. In essence, a program can "call" a variety of subroutines from disk.

Another important enhancement provides a sorting feature by using the statement:

```
ln CMD"O",n,(array variable list)
```

where *n* is the number of elements in the array to be

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sorted. The specifications allow for ascending and descending sorts, sorting a limited part of an array, and tagging other arrays onto sorts. Both strings and numbers can be sorted. It's not possible to describe all of the possibilities here, but the function is powerful and fast.

Changes in BASIC Invocation

Bringing up BASIC from the system mode is done by using the form:

BASIC *n*,*m*,line,

where line is any BASIC program line or statement, *n* sets the number of files to be made available, and specifying *m* will set the upper limit on available memory (*n*,*m*, and line are all optional). (BASIC may still be entered by typing the word BASIC alone.) The command can be followed by RUN or LIST with a program name, and the program will be run or listed. For example, entering the line:

```
BASIC 5,30000,CMD"DIR":RUN"TESTPROG/BAS"
```

would bring up BASIC, set up five files, protect memory from location 30000 on up, display the disk directory, and start to run the program TESTPROG/BAS.

The command BASIC * is quite useful: it allows recovery of a program even after an accidental reset. If the program is still in memory, the computer will reenter BASIC, list the program, and allow it to be executed. Of course, it will not work if something destroyed the program in memory. While BASIC is still enabled, RENEW performs a similar function by reinstating a program eliminated by the BASIC command NEW.

Editing and Program Manipulation

The original Level II BASIC provided a good line-oriented editor. V2 doesn't change this, but it adds many useful features.

The REF$ utility, for example, sends a cross-referenced list of all variables and integer numbers (mostly line numbers) to the printer (see listing 3). REF* sends the list to the screen. REFA gives all line numbers where variable *A* appears, and REF200 displays all references to integer 200, including line number 200. REF"The" finds all strings containing the word "The," and REF=FOR locates all references to FOR (not as strings, but in statements) in the program.

The CMD"C" utility compresses and manipulates the text of a program. CMC"C"alone removes both comment lines and spaces. CMD"C",R removes remarks alone, and CMD"C",S deletes only spaces.

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```
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```

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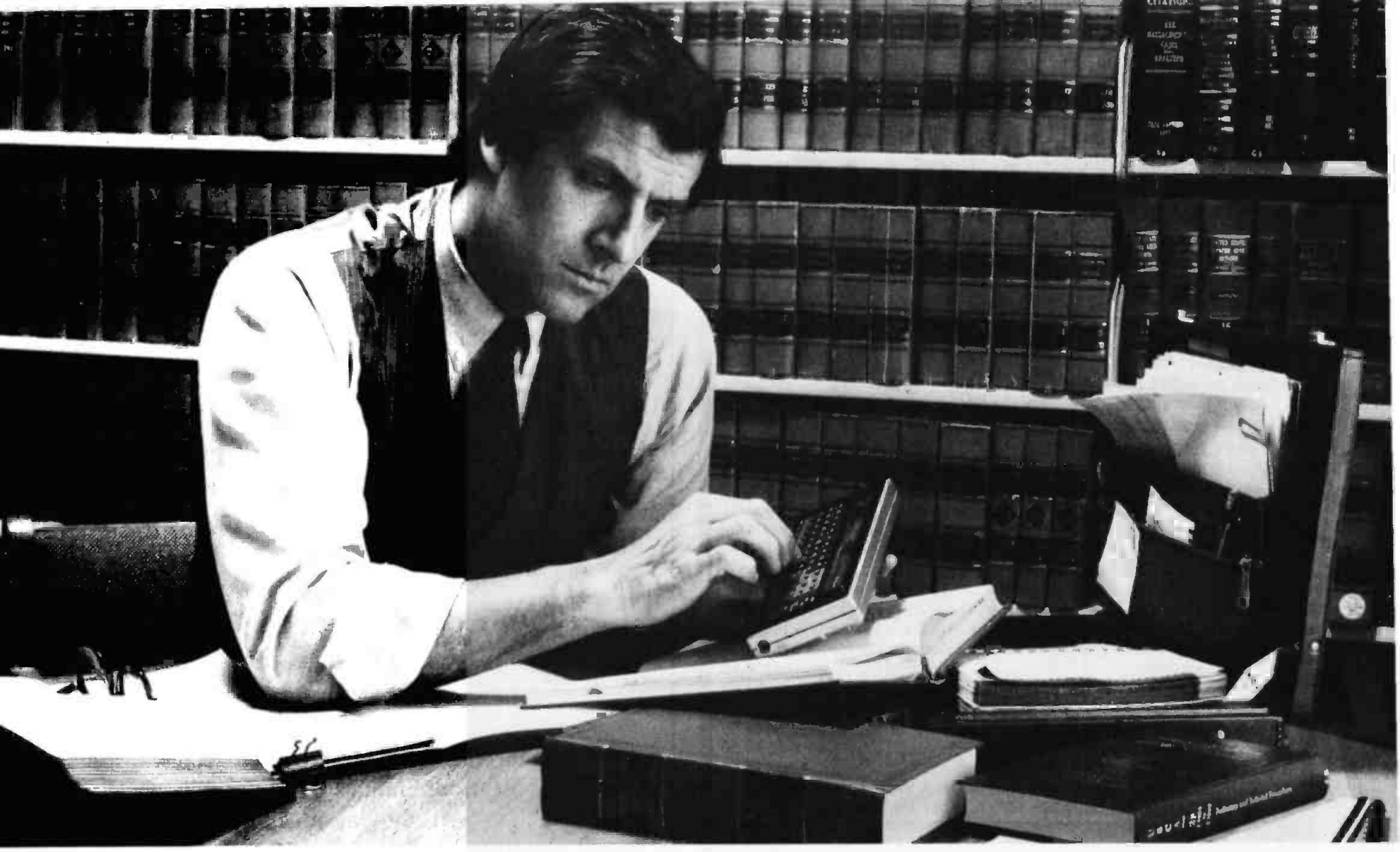

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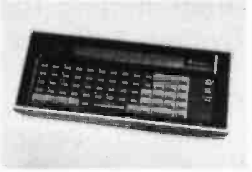

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will renumber everything with increments of 10 between lines. Entering:

```
RENUM 30000,5,15365,18112
```

would renumber all lines between 15365 and 18112 with an increment of five; the new numbering would start with 30000. Thus, 15365 would become 30000, 15366 would be 30005, and so on. All branches are kept track of, and you can't mix up two parts of the program. The function RENUM U is slightly different: it produces a list of all references to undefined lines (i.e., GOTO 1000 would be shown as an error if line 1000 didn't exist).

The DI and DU functions are closely related to RENUM. Entering the command:

```
DI 1005,2010
```

will displace (DI) line 1005 to 2010.

```
DU 1005,2010
```

will duplicate (DU) 1005 at 2010—but 1005 will still be at its original location. Similarly, D 1005 will delete (D) line 1005, which is the only way it can be done. You can no longer accidentally remove line 50 by typing the number 50.

Additional enhancements provided include a variety of abbreviated, single-character functions that are a great aid when writing and editing programs. For example:

- "." lists the current program line
- "," puts the current program line into the edit mode
- ";" or "shift up-arrow" lists the first program line
- "/" or "shift down-arrow" lists the last program line
- "up-arrow" displays the preceding line
- "down-arrow" displays the following line
- "+" scrolls one display page down
- ":" scrolls one display page up

The editing character must be the first and only entry on a line; backspacing is not allowed. However, pressing BREAK will reset things, permitting character entry. These functions allow rapid and simple program editing. I find myself editing programs on the screen that would have required a printed output with TRSDOS. (TRSDOS for the Model III, however, has many of these features.)

File Types

File types are the most confusing aspect of V2, although they are intuitively easy to grasp. The file structures and input/output procedures are similar to those normally found on much larger computers. The new files are powerful, but they're hard to describe, both in a review and in the documentation (Apparat devotes 80 pages to the file types).

Both the sequential and random files supported by TRSDOS and similar systems are maintained by V2, but V2's sequential and random files have new features. First,

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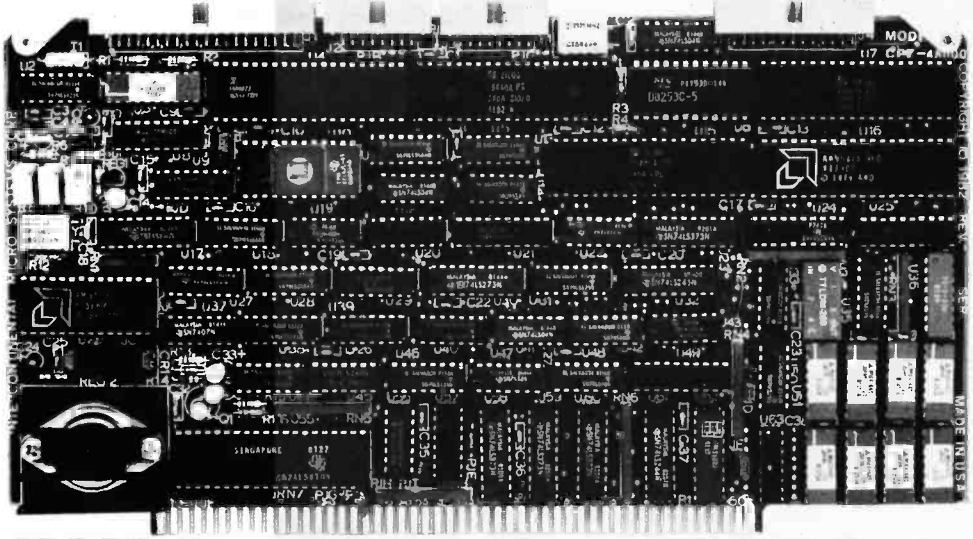

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Listing 4: *Superzap program menu.*

```
APPARAT'S SUPERZAP/80.  INPUT ONE OF THE FOLLOWING FUNCTIONS:
'DD'  -  OR NULL  -  DISPLAY DISK SECTOR
'DM'  -  DISPLAY MAIN MEMORY
'DFS'  -  DISPLAY FILE'S SECTOR
'DTS'  -  DISPLAY TRACK'S SECTOR
'DMDB'  -  DISPLAY MEMORY DUMP BLOCK
'VDS'  -  VERIFY DISK SECTORS
'ZDS'  -  ZERO DISK SECTORS
'CDS'  -  COPY DISK SECTORS
'CDD'  -  COPY DISK DATA
'DPWE'  -  DISPLAY PASSWORD ENCODE
'DNTH'  -  DISPLAY NAME/TYPE HASH CODE
'EXIT'  -  END SUPERZAP, EXIT TO DOS
PRINTER OUTPUT.  APPEND ,P TO DD, DM, DFS, DTS OR DMDB
```

Listing 5: *A directory sector as displayed by Superzap.*

```
DRV 00  5F20 0000 0053 5953 3120 2020 2053 5953 .....SYS1....SYS
0   10  5678 1234 0500 1000 FFFF FFFF FFFF FFFF V..4............
0H  20  5F20 0000 0053 5953 3920 2020 2053 5953 .....SYS9....SYS
    30  5678 1234 0500 1320 FFFF FFFF FFFF FFFF V..4............
DRS 40  5F20 0000 0053 5953 3137 2020 2053 5953 .....SYS17...SYS
175 50  5678 1234 0500 0A20 FFFF FFFF FFFF FFFF V..4............
AFH 60  1020 0062 0042 4153 5255 4E20 2043 4D44 .....BASRUN..CMD
    70  9642 9642 3900 0804 1906 FFFF FFFF FFFF .B.B9...........
    80  1020 0000 0041 5350 4F4F 4C20 204D 4153 .....ASPOOL..MAS
    90  9642 9642 0A00 1C21 FFFF FFFF FFFF FFFF .B.B...1........
    A0  1020 003B 0043 4841 494E 424C 4442 4153 ...;.CHAINBLDBAS
    B0  9642 9642 1400 1D23 FFFF FFFF FFFF FFFF .B.B...#........
FRS C0  0000 0000 0000 0000 0000 0000 0000 0000 ................
5   D0  0000 0000 0000 0000 0000 0000 0000 0000 ................
5H  E0  0000 0000 0000 0000 0000 0000 0000 0000 ................
 P  F0  0000 0000 0000 0000 0000 0000 0000 0000 ................
```

a sequential file can be opened at its end with data being added at that point (Model III TRSDOS also does this). You would normally open a sequential file at the beginning with the statement:

OPEN"O",1,"FILE/FIL"

which would open the file at the beginning only. The statement:

OPEN"E",1,"FILE/FIL"

will now open it at the end.

A second new feature is that random files can have variable logical record lengths, or LRLs. (In TRSDOS for the Model I, the length is fixed at 256 bytes.) BASIC must be invoked by a statement such as BASIC 3V; the V indicates that the files will have variable LRLs. Entering the statement:

OPEN"R",1,"FILE/FIL",128

will produce an LRL of 128 bytes. This arrangement is easier than using the complex bookkeeping required with other systems and it saves space.

Additionally, V2 has two file types that are found in no other operating system: marked item files (with three subtypes) and fixed item files (with two subtypes). Marked item files are intended to be similar to sequential files, but they use less disk space and are easier to access. Also, some other limitations of sequential files are removed. Fixed item files are similar to random files, although the FIELD statement, LSET, RSET, and other buffer-formatting statements are not used. The PUT and GET statements define the sequence of storage and recall of variables as well as the space allocated to each. Both file types can be used for random access.

Utility Programs

In addition to the various utilities that have already been described (e.g., REF and RENUM), V2 has several machine-language utility programs, including Superzap, DISASSEM, LMOFFSET, DIRCHECK, EDTASM, CHAINBLD, and ASPOOL.

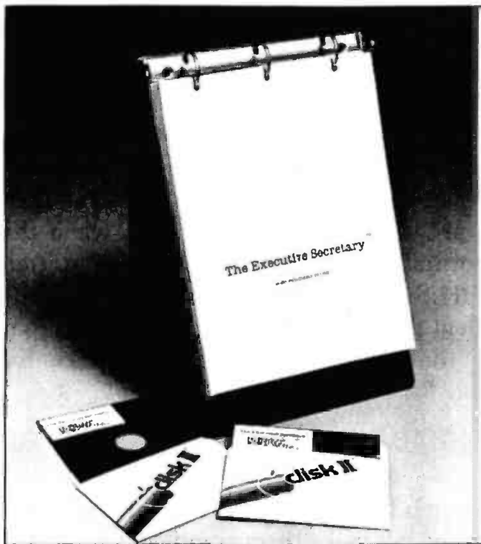
The most useful is Superzap. The menu shown in listing 4 describes its functions. The display mode (using DD, DM, DFS, DTS, or DMDB) gives sectors and 256-byte blocks of memory as shown in listing 5. The location and other data are on the left, the hexadecimal-byte values are in the middle, and the ASCII equivalents of the hexadecimal values are on the right. If a hexadecimal-byte value lacks an ASCII equivalent, a period is shown.

Several editing functions are available while in Superzap's display mode. The most important of these is MOD, which allows modification of a byte within the displayed sector. Here's how it works: a cursor appears that can be moved around as you see fit; modifications are made by simply typing over byte values. Preceding and following sectors can also be displayed. When you type ENTER, the system asks if the modification should be written to disk. This is how Apparat's updates (zaps) are made on system programs. The modify option can be used to change file names and dates, to repair disk directories, and to change text files. Two other editing functions, F and L, are available. F is quite important: it searches a disk, file, or memory for a value up to four bytes. For example, entering the command F,2A,5C,33,AC would find those four hexadecimal bytes. Another function, SCOPY (DD and DTS modes only), allows the displayed sector to be copied to another sector on the disk.

DISASSEM/CMD is capable of disassembling object code from a tape, disk, or memory, displaying the Z80 mnemonics, providing a printed listing, and sending the generated source code to a new disk file. The source code may then be modified and reassembled using the EDTASM/CMD program. There are a variety of other options, and this is a very powerful disassembler.

LMOFFSET/CMD reads a machine-language program from tape or disk, displays the start, end, and entry locations, allows relocation of the program load address, optionally sets up the program so that it can be loaded from disk and executed under the nondisk BASIC Level II SYSTEM command, and dumps the code to tape or disk. I have found little need to offset program locations using this routine, but its ability to tell me the start and end locations is handy. Most important, however, is its ability to dump a machine-language program from disk to tape (new to V2); this is invaluable for transferring programs to systems without disk drives.

DIRCHECK/CMD performs a simple but essential function: it checks the disk directory. It also lists the directory, characteristics of the files, and gives messages



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relating to any problems. The error messages can be difficult to understand without careful reading of the documentation.

EDTASM/CMD is best understood by quoting the V2 user's manual:

> *Thirty-five months ago Apparat converted the TRS-80's tape-oriented editor/assembler to:*
>
> 1. *Read text from disk as well as cassette.*
> 2. *Write text and/or object to disk as well as cassette. . .*
> 3. *Allow scrolling to display up to 15 text lines.*
> 4. *Prevent the confusing printer output associated with DEFM. . .*
> 5. *List symbols in alphabetical order with reference list.*
> 6. *Accept and convert lowercase to upper[case].*

The manual also states that EDTASM is a modification of Radio Shack's copyrighted product, so all users *must buy the original*. In addition, Apparat provides documentation for the enhancements only. If you want to use EDTASM, you must have the manual for Radio Shack's tape-based editor assembler.

CHAINBLD/BAS is a BASIC program that constructs or edits a job-control-language file (see above). The same file can be written more easily using Scripsit; however, with earlier versions of NEWDOS, you had to write a BASIC program to create the JCL file. The CHAINBLD/BAS program is better than other versions that are on the market.

The ASPOOL utility speeds program execution while output is being sent to a printer. Print-data is sent to a disk buffer and from there to the printer without delaying the program. Because disk output is much quicker than printer output, program execution continues when the printer would normally be active. ASPOOL was written by a consultant (H.S. Gentry), not by the Apparat staff, and it's an excellent program. One reviewer has said that the value of the spooler equaled the price of NEWSDOS/80.

Compatibility

The TRS-80 Models I and III have different ROMs, and no operating system can make them completely compatible. Yet, the ROMs are similar, and most programs will operate on both. The main problem is the transfer of software. TRSDOS for the Model III permits a limited transfer from the Model I's single-density disks, but not the reverse. V2 allows two-way transfers, and you can copy double-density disks created on either computer. If PDRIVE and SYSTEM are set correctly, either computer can read files and execute programs written by the other. With single-density disks, the WRDIRP command may have to be used, but that's simple. V2 seems to allow as much compatibility between the two computers as is possible.

V2 for the Model I is a different system than that for the Model III. If you have both a Model I and a Model III, you will need V2 on both computers to use the disks interchangeably.

Documentation

The documentation for NEWDOS has been notoriously poor. The first versions were simply supplements to the TRSDOS documentation. NEWDOS/80 Version 2's documentation is much better. It consists of more than 260 pages of very detailed text with an index and a good table of contents, packaged in a three-ring binder. For the machine-language programmer, the documentation has a lot of technical detail. But the first-time user may have a problem. All the information you will need is in the documentation, but you need some understanding of operating systems to use it.

The text is not a tutorial for the newcomer, but Apparat has tried to include examples for the novice, and it has mostly succeeded. Although you may have to do some studying, everything is spelled out in regard to commands, BASIC enhancements, and so forth. The problem is that the documentation is written by experts for experts. For example, I doubt that anyone will be able to understand the file types without first understanding sequential and random files in TRSDOS. Reference is even made to the TRSDOS manual. If V2 is a stand-alone system, it seems odd to expect people to buy the TRSDOS manual. If you want to use the most important features of V2, you should have no problem with the documenta-

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Unfortunately, the loops and tests and flags that work so well for a small program get out of control very rapidly as the program grows. Pretty soon, some of the things the program must do are not being done fast enough. The code gets too complicated, difficult to modify and unreliable. The result: another software failure!

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tion that's supplied. But if you have no experience using a DOS, then you should expect to do a lot of studying. I hope that someone will write a V2 manual for the newcomer. Apparat has not done it.

Conclusion

The TRS-80 is now served by more than nine operating systems. In my opinion, a satisfactory system must provide double-density operation, optimal compatibility between the Model I and the Model III, and flexibility in system configuration. At least two DOSes meet these criteria: LDOS and NEWDOS/80 Version 2.0. (See "LDOS—Disk Operating System for the TRS-80," by Tim Daneliuk, March 1982 BYTE, page 372.) They are both superior to any operating system I have used on any mini- or microcomputer. If they were designed for a less common machine, they would cost many thousands of dollars. In fact, if purchased separately, the cost of a few of the utilities in NEWDOS/80 Version 2.0 would probably be more than the complete operating system.

I believe that NEWDOS/80 Version 2.0 is the most powerful operating system available for the TRS-80 Models I and III. As far as I know, it has all of the important features of other operating systems for TRS-80s. Some DOSes may have other options, such as the filtering procedures of LDOS, but those are made up for by such things as V2's BASIC enhancements, Superzap and other utilities, and by improved file types. Above all, V2's flexibility in supporting various system configurations and allowing compatibility between the Models I and III is outstanding.

Given my choice, I would rather own an Aston Martin than a Ferrari, but I recognize that the choice is subjective. The choice between NEWDOS/80 Version 2.0 and some of its competitors may be equally subjective, but it's one of the best operating systems ever designed.■

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Book Reviews

Beneath the Apple DOS

Don Worth and
Pieter Lechner
Quality Software
Reseda, CA, 1981
166 pages,
softcover, $19.95

Reviewed by Rob Moore
Warner Hill Rd.
RFD #5
Derry, NH 03038

Beneath the Apple DOS, by Don Worth and Pieter Lechner, is the first publication that truly explains the innermost workings of the Apple II's disk operating software.

Since the Apple Disk II first became available to the public, users have been trying to gain access to the inner DOS routines with varying degrees of success. With the exception of the low-level RWTS (read-write-track-sector) disk drive, Apple Computer Inc. has never published the source listing or any other information to help the user access the DOS internals.

The reasons for this are understandable. Many people have difficulty with assembly language and publication of the DOS information could result in a tremendous influx of phone calls to Apple from users with questions. Also, Apple's DOS represents a large development expense and the source listings are proprietary. They were never designed to be accessed internally by the casual user.

Beneath the Apple DOS removes most of the mystery. The book describes the operation of the Apple DOS from the file buffers at one end to the RWTS routines at the other. The book contains numerous diagrams, tables, and example listings of assembly-language programs using DOS features that are normally inaccessible to the user. I did notice one significant error, but it doesn't affect the accuracy of the rest of the information.

Following the introduction and a short history of Apple DOS, the third chapter provides an excellent discussion of the Apple disk format. Even though much of this information has been previously published, it's presented in such a clear and organized fashion that it will be helpful even to disk "experts." After discussing tracks and sectors, the authors describe how data is actually written on the disk surface. Although the authors have an excellent grasp of the DOS software, their discussion of data bits and clock bits stored on the disk surface is almost entirely incorrect. (This was verified with Randy Wigginton, author of the DOS RWTS routine at Apple Computer Inc. For an explanation of the actual storage method see the accompanying "Apple Disk Storage" text box.) Once past the point where the authors describe the physical bit-storage method, the information is again correct (as far as I know) and very useful.

The balance of the book is excellent. The material is well organized and presented in a clear, understandable manner. In particular, Chapter Six—"Using DOS from Assembly Language"—provides all the details necessary to directly control the Apple disk, use the DOS RWTS routines, or access the disk with the DOS File Manager.

The information describing the File Manager routine has never before been published and will be invaluable to any programmer writing disk utilities or applications programs that require a special interface to DOS files. Using the File Manager, the programmer can easily create, open, access, and close DOS files with complete access to all of the file internals. For example, you may cue the File Manager to read or write any single byte or range of bytes within any file of any type. (The Apple FID and MUFFIN programs use the File Manager to accomplish their functions.)

The book also contains a complete list of all DOS entry points and key addresses along with descriptions of several ways to customize DOS. The authors provide five example programs to illustrate direct control of the disk, use of the RWTS routines, and use of the File Manager.

For those interested, the authors briefly discuss disk-protection methods and bit copiers. The discussion is general, however, and does not describe specifically how to "break" protected disks or how to protect your own.

In conclusion, *Beneath the Apple DOS* is an excellent book. It's the only one of its type and should be part of every Apple assembly-language programmer's library. The authors deserve congratulations. ■

Apple Disk Storage

FM Recording

The disk-storage method described in Beneath the Apple DOS *is called FM (or frequency-modulated) recording. This is the industry-standard single-density recording method and can typically store 80.6K bytes of memory on a standard 35-track 5¼-inch floppy disk.*

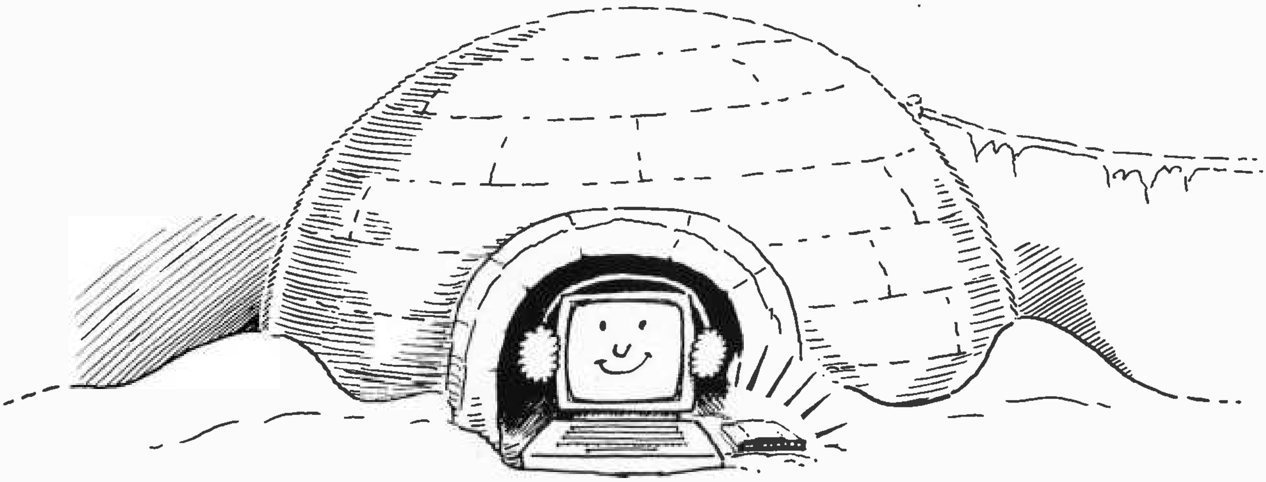
On an FM-recorded disk, each bit of data is stored as a "clock" bit followed by the presence or absence of a "data" bit. The clock bits each define the beginning of a time "window" (or bit cell) in which a data bit may be present and are necessary to deal with the timing shifts caused by rotational speed variations.

While FM recording is reliable and easy to decode, it is relatively inefficient because two bits are written for each actual data bit stored. More efficient encoding methods can increase the amount of usable data stored on each disk track.

GCR Recording

The Apple Disk II achieves its 143K-byte storage capacity through a modified form of GCR (or group-coded recording). Rather than storing alternate clock and data bits, Apple's form of GCR assembles 6 data bits into an encoded 8-bit group and writes the group to the disk without interleaved clock bits. So, where FM recording would write 12 bits, the Apple actually writes 8 bits to gain a 50 percent increase in effective density.

Apple's GCR encoding rules are very well described in Beneath the Apple DOS. *If all references to clock bits are disregarded, the information is correct and very useful.*



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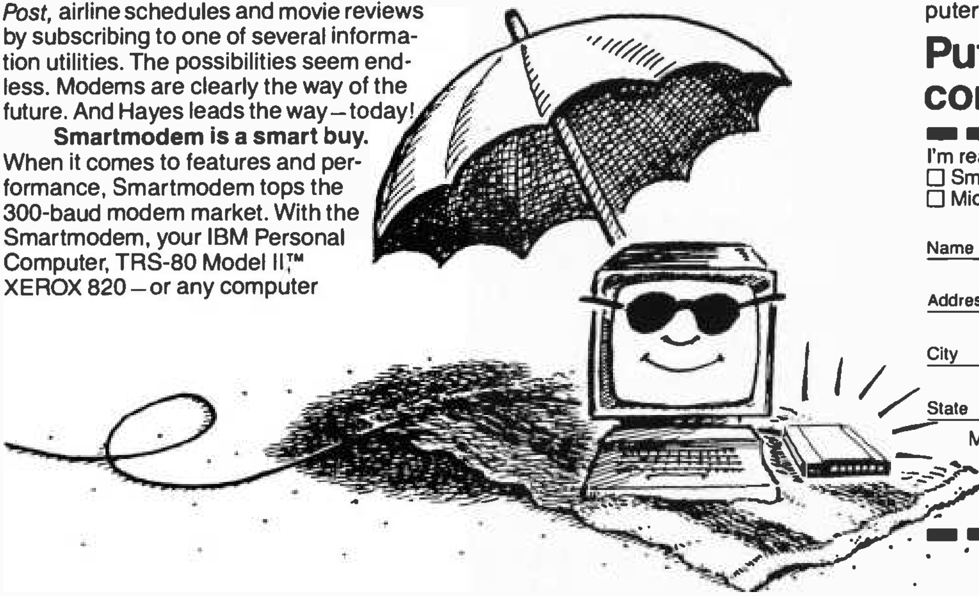

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Circle 209 on Inquiry card.

System Notes

Adapting "Harvesting the Sun's Energy" for the Commodore PET

Jerry Berry
11558 East Wesley Ave.
Aurora, CO 80014

My July 1981 BYTE with "Harvesting the Sun's Energy" by George Mobus (page 48) arrived just as I was completing the framework for mounting solar collectors at my home in Aurora, Colorado. I wasted no time in adapting his program, which helps determine the amount of solar energy received by a flatplate collector, to run on my PET, which uses the upgraded ROMs (read-only memories). Though the majority of the changes necessary were in the print routines, it was also necessary to replace the backslash with the PET colon for multiple statements on a single line.

The program in listing 1 directs the questions and answers to the PET video display and then formats and directs the output to a printer (identified as device #4 on the PET IEEE-488 bus). Lines 140 to 250 perform this function and can be modified if a different output channel or device is desired. Lines 240 to 244 set up the format for the printer and assume that a formattable printer, such as the Commodore 2022, is available.

A run for my Aurora location is shown in listing 2. A comparison of this run with others at various tilt angles convinced me that 55 degrees was the best compromise between winter performance and overall yearly heat gain.■

Listing 1: *BASIC program adapted to run on the Commodore PET with the upgraded ROMs. It calculates the total energy falling on a flatplate collector for various combinations of tilt angle, azimuth (south = 0°), and location. This program is an adaptation of the one by George Mobus that appears in the July 1981 BYTE, page 50.*

```
10 REM...COMPUTE AND PRINT DAILY SOLAR
30 REM...FLUX ON FLAT PLATE COLLECTOR
35 REM...FROM JULY 81 BYTE,G.E.MOBUS
40 RESTORE
50 CLOSE 1:CLOSE 2:CLOSE 3
60 PRINT"⊐"
70 DIM I(11):F=π/180
80 PRINT"TABLE OF BEAM RADIATION SOLAR ENERGY"
90 PRINT:PRINT
100 PRINT"ENTER DATA (DECIMAL VALUES) AS REQUESTED"
110 PRINT:INPUT "LATITUDE";L:L=L*F
120 PRINT:INPUT"TILT ANGLE";T:T=T*F
130 PRINT:INPUT"AZIMUTH ANGLE";A:A=A*F
140 OPEN 1,4
150 CMD 1
160 PRINT"⊐";TAB(26);"TABLE OF SOLAR RADIATION"
170 PRINTTAB(24)"BTUS PER SQUARE FOOT PER HOUR"
171 PRINT
172 PRINTTAB(10);"LATITUDE:";L/F;"    TILT ANGLE:";T/F;"    AZIMUTH:";A/F
```

Listing 1 continued on page 406

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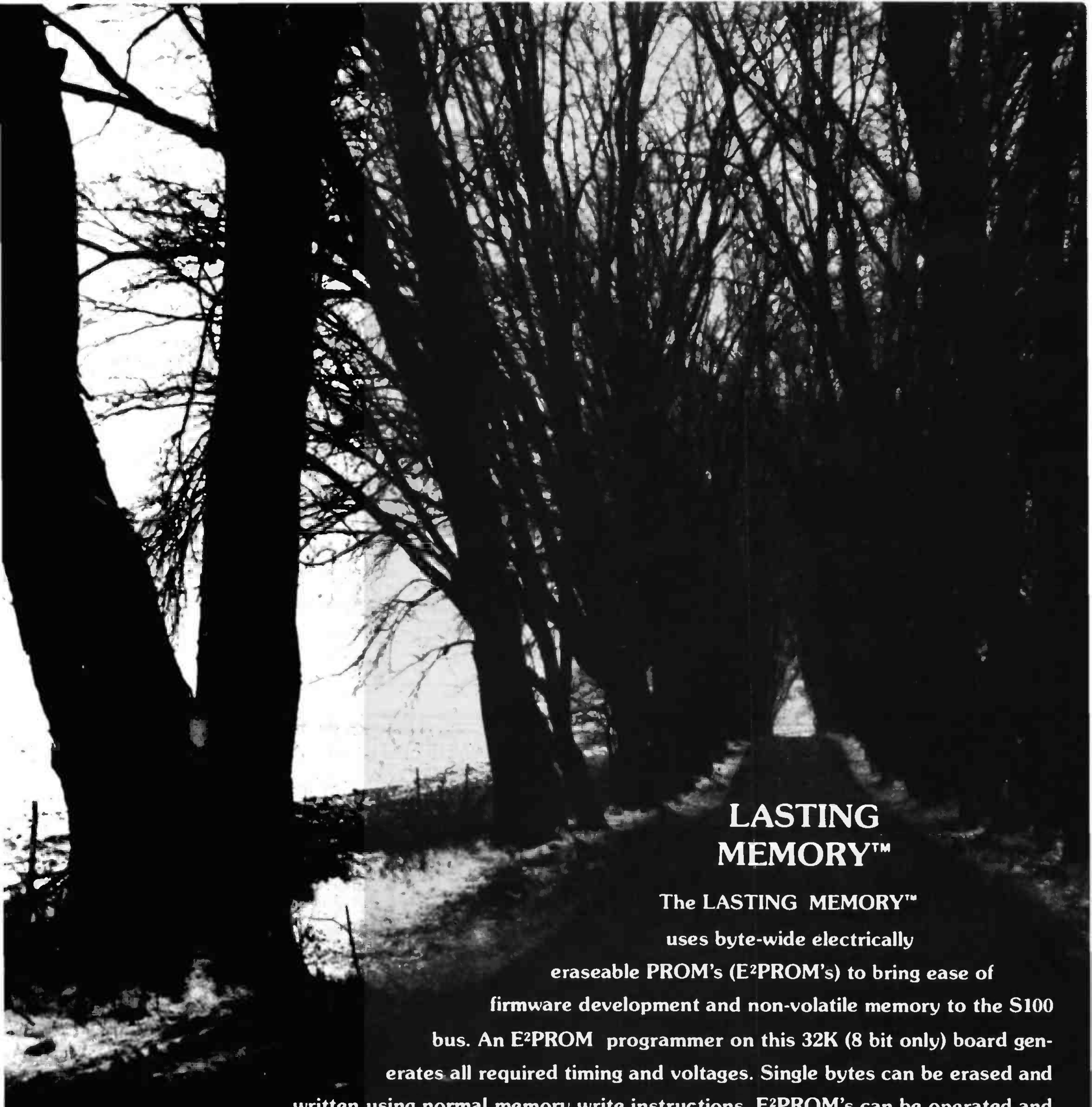
Listing 1 continued:

```
 174 PRINT
 180 PRINT:PRINTSPC(35);"SOLAR HOUR"
 190 PRINTSPC(18);"MORNING";SPC(12);"NOON";SPC(10);"AFTERNOON"
 200 PRINT"   MONTH";:FOR J=7 TO 12:PRINTSPC(2);J;:NEXT J
 210 FOR J= 1TO 5:PRINTSPC(2);J;:NEXT J:PRINT"   TOTAL"
 220 PRINTSPC(3):FOR I = 1 TO 70:PRINT"=";:NEXT I:PRINT"="
 230 PRINT#1:CLOSE 1
 240 OPEN 2,4,2
 241 PRINT#2,"    99  99999  999  999  9999  9999";
 242 PRINT#2," 9999  999  999  999  999  999   99999"
 244 CLOSE 2
 250 OPEN 3,4,1
 260 FOR Q=1 TO 12
 270 READ N:H=75:P=0
 280 FOR B = 1 TO 11
 290 H1=H*F:GOSUB 350:I(B)=I:H=H-15:P=P+I(B)
 300 NEXT B
 310 PRINT#3,SPC(5);Q;:FOR Z=1 TO 11:PRINT#3,I(Z);:NEXT Z:PRINT#3,P
 320 NEXT Q
 330 PRINT#3:CLOSE 3
 340 PRINT"END OF RUN":END
 350 REM ...SUBROUTINE TO COMPUTE
 360 REM....SOLAR INSOLATION PER HOUR
 370 I=429*(1+(.034*COS(360*N/365*F)))
 380 D=23.45*SIN(360*(284+N)/365*F):D=D*F
 390 S=SIN(L)*SIN(D)+(COS(L)*COS(D)*COS(H1))
 400 M=SQR(1229+(614*S)↑2)-(614*S)
 410 IF M>94.976 THEN E1=0:GOTO 430
 420 E1=EXP(-.65*M)
 430 E2=EXP(-.095*M)
 440 I=I*.56*(E1+E2)
 450 C=SIN(D)*(SIN(L)*COS(T)-(COS(L)*SIN(T)*COS(A)))
 460 C=C+COS(D)*COS(H1)*(COS(L)*COS(T)+(SIN(L)*SIN(T)*COS(A)))
 470 C=C+COS(D)*SIN(T)*SIN(A)*SIN(H1)
 480 I=I*C:R=INT(I):O=I-R
 490 IF O>.5 THEN I=R+1:GOTO 510
 500 I=R
 510 IF I<0 THEN I=0
 520 RETURN
 530 DATA21,52,80,111,141,172,202,233,264,294,325,355
READY.
```

Listing 2 is on page 408



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Listing 2: *Sample output of the program in listing 1. By running the program for various values of tilt angle, I determined that 55 degrees provided the best compromise of winter performance and overall yearly heat gain.*

```
                    TABLE OF SOLAR RADIATION
                  BTUS PER SQUARE FOOT PER HOUR

         LATITUDE: 39.8      TILT ANGLE: 45     AZIMUTH: 0


                                  SOLAR HOUR
                MORNING              NOON            AFTERNOON
MONTH     7     8     9    10    11    12     1     2     3     4     5     TOTAL
=============================================================================

  1            66   143   207   249   264   249   207   143    66            1594
  2      20    95   173   239   282   297   282   239   173    95    20      1915
  3      41   116   194   259   301   316   301   259   194   116    41      2138
  4      49   123   198   259   299   313   299   259   198   123    49      2169
  5      49   120   190   247   284   297   284   247   190   120    49      2077
  6      48   117   185   240   276   288   276   240   185   117    48      2020
  7      49   119   189   245   282   295   282   245   189   119    49      2063
  8      49   122   196   256   296   309   296   256   196   122    49      2147
  9      41   115   192   256   298   312   298   256   192   115    41      2116
 10      19    93   170   235   278   292   278   235   170    93    19      1882
 11            64   140   204   246   261   246   204   140    64            1569
 12            50   127   191   233   247   233   191   127    50            1449
```

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TAFT

Terminal Apple with File Transfer

Low-cost telecommunication capability for the Apple II

Tom Gabriele
Cardigan Rd.
Timonium, MD 21093

Has your Apple computer ever sat around alone and unused on a Saturday night? TAFT (Terminal Apple with File Transfer) is a short but useful program that turns an Apple II into a simple CRT terminal. With it, you can access the host computer at school or work and reach data in computer bulletin-board systems.

TAFT has two main functions. First, it handles the interchange of individual characters between a serial communications port, the keyboard, and the CRT display to make the Apple function as a simple terminal. Second, the program transfers the contents of text files (bidirectionally) between the Apple floppy-disk drives and the host computer disk storage.

Like any CRT terminal, your Apple can give commands to, and interchange data with, a host computer. The host computer could be located in the same building as the Apple or, with the aid of a modem (modulator/demodulator) and your telephone, it could be across the country. Rather than staying late at work to finish what you're doing on the host computer, you can have dinner with your family at home, use your Apple II to call the host computer, and finish your task later in the evening. The user load on the host computer during off hours is probably much lighter. Therefore, the host computer can give you more of its undivided attention and will exhibit faster response and throughput.

TAFT ignores any input from its keyboard and communication line while it writes the contents of its receive buffer to disk.

You should be able to use TAFT, without modification, as a terminal with *any* host computer. As written, however, TAFT will exchange disk files only with a DEC (Digital Equipment Corporation) VAX-11 timesharing host computer running the standard VMS operating system. (VAX and VMS are trademarks of DEC.) But without access to a VAX-11, you can still use TAFT to exchange files with your host computer because only two of its Applesoft statements (280 and 630) are "VAX-specific." The purpose and content of both statements are thoroughly described here, allowing you to easily modify TAFT to exchange files with other hosts.

TAFT communicates with its host computer using the RS-232 serial interface. The only hardware required by TAFT is a serial I/O (input/output) interface board. (An appropriate board is available from Electronic Systems, POB 21638, San Jose, CA 95151, telephone (408) 448-0800.) This board provides the full-duplex (send and receive simultaneously) bipolar voltage input/output as specified by the RS-232 standard. It is available without parts as a "bare board"; with all parts as a kit; and assembled and tested. (I purchased the kit and had it assembled and working in one evening.)

The RS-232 serial interface is asynchronous, meaning that the serial sequence of bits for each character is synchronized independently—making a separate clock signal unnecessary. The data-in, data-out, and ground signals from this board may be connected directly to the host computer at one of its RS-232 ports. Alternately, the board can be attached to a modem for remote communication with the host computer.

TAFT has been extensively tested with the serial board speed set at 300 bps (bits per second), about 30 characters per second. The majority of readily available, inexpensive modems operate at this data rate and most are compatible with the Bell-103 standard. Although 30 characters per second may seem a little slow (and it is for large file transfers), it permits you to immediately monitor what the host computer is sending as it is sending it. Faster data rates flash the characters by on the screen too rapidly to be read. If the Apple is directly connected to the host computer, much faster data rates are practical.

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About the Author

Tom Gabriele has been an electrical engineer for more than 15 years. He is interested in the application of microcomputers to music and chess.

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character-handling portion is written in assembly language, it should be able to operate as a terminal and transfer files at speeds much higher than 300 bps. A problem could develop with high-speed file transmission from the Apple to the host if the Apple sends characters faster than the host can accept them. Some hosts will send a Control S character back to the terminal telling it to delay sending more characters. When the host can once again accept the transmission, it will send a Control Q, telling the terminal that it's okay to continue.

A problem may arise with rapid (greater than 300 bps) file transmission because TAFT ignores the host computer while it is sending the contents of a disk file. If when verifying the contents of a "high-speed" transfer you discover portions of the file missing, you may assume that the host lagged behind the Apple II. Should this occur, a simple solution is to insert a short delay (by means of a FOR . . . NEXT loop) after each line of characters is transmitted. Use the shortest delay that avoids any character loss for your host. This problem should not arise at 300 bps operation, a data rate that should be acceptable to even the slowest host computer.

To handle high-speed file transfer from a host to the Apple, TAFT buffers (temporarily stores) the entire contents of the received file in main memory (RAM) as it is received. TAFT does not store early portions of the incoming file on disk while portions of the file are still being received. If it did store them, TAFT might lag behind high-speed transfers, losing some data as a consequence.

This design decision limits the largest file size transferable from the host computer to the Apple II. The file cannot be larger than the RAM buffer of a 48K-byte Apple II. The buffer begins at memory address 6144 (decimal) and ends at memory address 36864. Therefore, the largest file transferable to the Apple II is 36864 − 6144, or 30,720 bytes (or characters), a large file by normal Apple standards. The size of a file sent from an Apple to a host is limited only by the Apple disk's capacity.

TAFT has three modes of operation: terminal mode, transmission mode (file transfer from Apple to host), and reception mode (file transfer from host to Apple).

Terminal Mode

You will use TAFT most often in the terminal mode, where it begins operation. Terminal mode is used to sign the host on and off, to give the host any command, and to receive the host's response. The only reason to ever leave the terminal mode would be to transfer a disk file.

In the terminal mode, every character from the Apple keyboard is sent to the host immediately, except one: the Control T. When a Control T is keyed, TAFT exits from the terminal mode. The Control T was chosen to exit because this control character does not have a special function on most host computers, and "T" is a good mnemonic for file Transfer. (If your host computer supports Control T functions, you can choose another control character to exit the terminal

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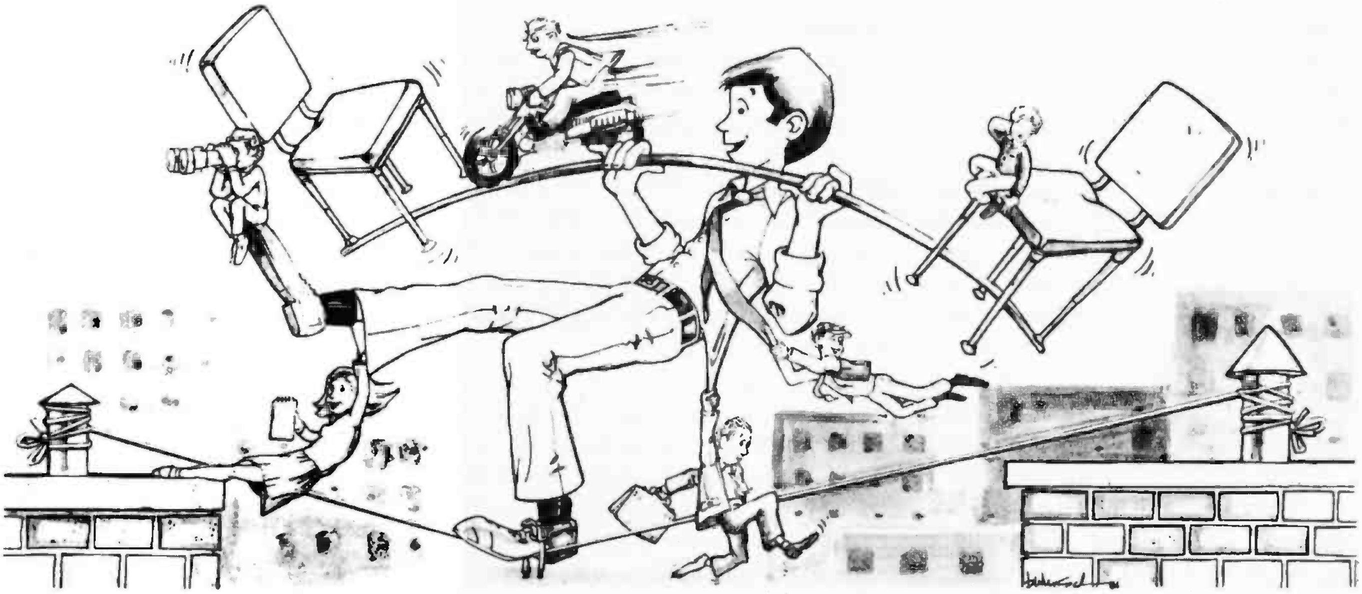

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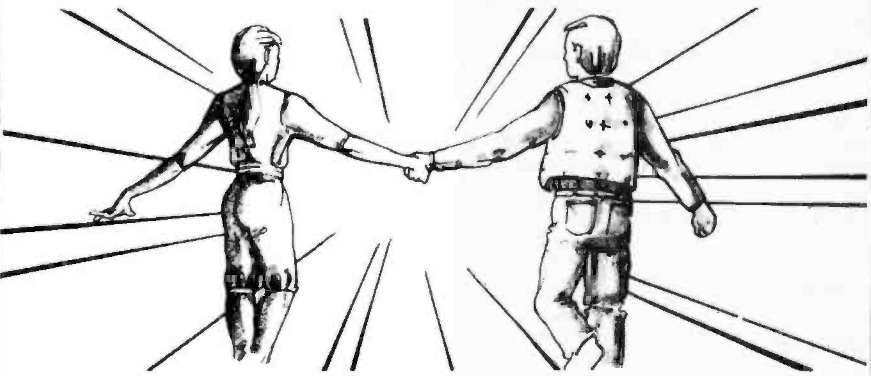

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mode. Listing 2, which is the assembly-language form of the data in lines 930-1030 of listing 1, explains how to modify TAFT to use whatever control character you choose.)

The Apple keyboard does not have three keys that are very useful in terminal-to-host communication: a delete key that removes the previous character, a horizontal-tab key, and an open-bracket key, "[". TAFT provides all three key functions by assigning these ASCII (American Standard Code for Information Interchange) values to other keys. When you press the *back-arrow* key, TAFT sends an ASCII Delete character. Press the *forward-arrow* key, and TAFT sends an ASCII Horizontal Tab character. And when you press a Control M, TAFT sends the ASCII "[" character. (The close-bracket character "]" is already available on the Apple keyboard as a shift M.)

Since an unmodified Apple can display only uppercase characters, all lowercase characters received from the host computer are automatically converted to uppercase prior to display. (If your Apple displays lowercase ASCII characters, you can defeat conversion by changing the "32" "0" in the middle of the data statement in line 970.)

In summary, the terminal mode simply sends all keyed characters to the host and displays all characters coming from the host.

Transmission Mode

After leaving the terminal mode (by keying Control T), you can enter the transmission mode by answering Y or YES to the first on-screen prompt, FROM APPLE TO HOST? TAFT then requests the name of the Apple source file to be transferred and the name this file will be given at the host computer. The Apple source file must be a text file.

TAFT displays each line of the file (delimited by a carriage-return character) after its transmission to the host. Any lowercase characters in the transferred file will appear as gibberish. The file transmission mode ends by displaying a brief end-of-transmission message, clearing the screen and returning to the terminal mode.

You can verify that the file was transmitted by commanding the host computer to transmit the contents of its new file back to the Apple. Since TAFT is now in the terminal mode, the received characters would be displayed on the Apple screen for direct verification. (Most host computers have a TYPE or similar command to do this.)

Reception Mode

If you answer anything but Y or YES to the first prompt, the next question is whether you want to *receive* a host-resident file. If the reply is Y or YES, TAFT prompts you to input the name of the source file to be received from the host and the name by which the Apple will store the file. Any existing file with this name will be overwritten. The new Apple file will be a text file, so it can be an input file to any Apple program *or* sent to this or another host using the previously described TAFT file transmission mode. You can also specify whether incoming lowercase characters are to be converted to uppercase. After this final operator input, TAFT begins the file-transfer process. It sends a message to the host requesting transmission of the specified file contents. Each received character is immediately displayed to you.

Upon receiving an end-of-file character (Control Z) from the host, TAFT ignores any input from its keyboard and communication line while it writes the contents of its receive buffer to disk. This operation is performed in Applesoft, rather than machine language, so the disk-write operation requires patience. Upon completion of the Apple disk file, TAFT gives you an end-of-transmission message and automatically initiates a disk catalog so that you can immediately verify that the new file has been added. When you finish reviewing the catalog, press any key and TAFT will return to the terminal mode.

Use the following procedure to terminate TAFT operation: exit the terminal mode with a Control T, decline both transmit and receive file-transfer prompts, and respond Y or YES to the QUIT? prompt. Any other response to the QUIT? prompt will return TAFT to its terminal mode. It is important that you exit TAFT in this manner; otherwise only a small amount of memory (RAM) will be

Text continued on page 420

A$ = operator responses and host commands to be sent to the host.
AF$ = name of Apple disk file.
BOO = the DOS or Applesoft error number if one occurred. The value is PEEKed from location 222 (see page 114 on the Apple DOS 3.2 manual).
C$ = utility storage for a single character and operator case-conversion decision.
C = numeric value of received character.
CA$ = the Control A character.
CNV = operator case-conversion decision, 0 or 1.
CZ$ = the Control Z character, indicating end-of-file to the host.
D$ = the Control D character for accessing DOS functions from BASIC (see page 29 of the Apple DOS 3.2 manual).
HOTAP = calling address of the host-to-Apple file-transfer, machine-language program.
I = loop index.
L$ = the line of characters currently being composed before being written to the new file or displayed.
LAST = address of the 1-byte output buffer for characters to be sent on the communication line.
OUTCHR = character-output machine-language, routine calling address.
PLACE = loop index used as the address to store machine-language code bytes.
PTR = memory address where the machine-language portion of the file-reception mode will store the address in the receive buffer of the last character received.
R$ = the carriage-return character.
TERMA = calling address of the machine-language subroutine to implement the terminal mode; TERMinal Apple.
VF$ = name of the host file being read or written.
X = the numeric value of a machine-language byte of code.

Table 1: *The variable names and functions of TAFT.*

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Listing 1: *TAFT (Terminal Apple File Transfer) program written in Applesoft BASIC.*

```
10  REM  **********************************
20  REM  **    T  A  F  T                **
30  REM  **    Terminal Apple     with   **
40  REM  **          File Transfer       **
50  REM  **    by     Tom Gabriele       **
60  REM  **********************************

70  HIMEM: 6143: REM   $17FF
80 PTR = 254: REM  $FE
90 D$ =  CHR$ (4):R$ =  CHR$ (13):CA$ =  CHR$ (1):CZ$ =  CHR$
(26)
100 OUTCHR = 36959: REM   $905C = OUTPUT ROUTINE CALLING
ADDRESS
110 LAST = 36973: REM  $906D = STORAGE ADDRESS FOR OUTPUT
CHARACTER
120 HOTAP = LAST + 1
130 TERMA = 36864: REM   $9000 = ALC STARTING ADDRESS
140  GOSUB 930
150  HOME : PRINT "ENTERING HOST TERMINAL MODE."
160  CALL TERMA: REM   TRANSFER TO ALC
170  INPUT "FROM APPLE TO HOST? (Y/N)";A$
180  IF  LEFT$ (A$,1) = "Y" THEN 260
190  INPUT "FROM HOST TO APPLE? (Y/N)";A$
200  IF  LEFT$ (A$,1) = "Y" THEN 570
210  INPUT "QUIT?";A$
220  IF  LEFT$ (A$,1) <  > "Y" THEN 150
230  HIMEM: 38400
240  PRINT : PRINT "GOOD-BYE!": PRINT
250  END
260  INPUT "APPLE SOURCE FILENAME?";AF$
270  INPUT "HOST DESTINATION FILENAME?";VF$
280 A$ = "CREATE " + VF$ + R$
290  FOR I = 1 TO  LEN (A$)
300  POKE LAST, ASC ( MID$ (A$,I,1))
310  CALL OUTCHR
320  NEXT I
330  ONERR  GOTO 520
340  PRINT D$;"OPEN ";AF$
350  PRINT D$;"READ ";AF$
360 L$ = ""
370  GET C$
380  POKE LAST, ASC (C$)
390  CALL OUTCHR
400  IF C$ = R$ THEN  GOTO 430
410 L$ = L$ + C$
420  GOTO 370
430  PRINT R$;D$
440  PRINT CA$;L$
450  GOTO 350
460  REM   EOF DETECTED, FINISH TRANSFER
470  POKE LAST, ASC (CZ$)
480  CALL OUTCHR
490  GOSUB 920
500  FOR I = 1 TO 500: NEXT I
510  GOTO 150
520 BOO =  PEEK (222)
530  PRINT D$;"CLOSE ";AF$
540  IF BOO = 5 THEN  GOTO 470
550  PRINT "ERROR NUMBER ";BOO;" OCCURRED."
560  GOTO 470
570  REM   FILE TRANSFER FROM HOST TO APPLE
580  INPUT "HOST SOURCE FILENAME?";VF$
```

Listing 1 continued on page 418

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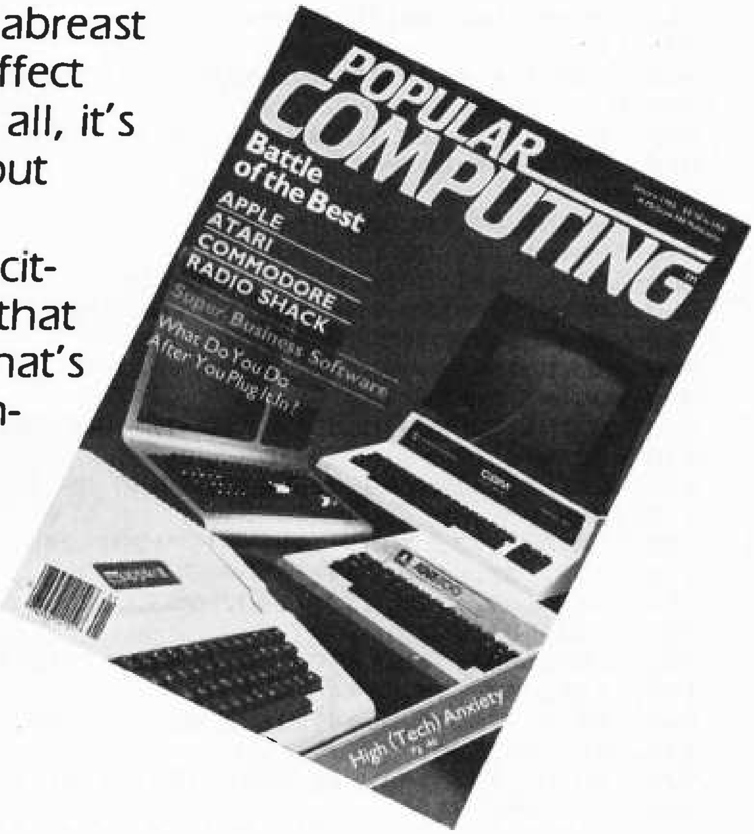

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Listing 1 continued:

```
590  INPUT "APPLE DESTINATION FILE?";AF$
600 CNV = 0
610  INPUT "UPPER CASE CONVERSION? (Y/N)";C$
620  IF  LEFT$ (C$,1) = "Y" THEN CNV = 1
630 A$ = "@TYPAPL " + VF$
640  FOR I = 1 TO  LEN (A$)
650  POKE LAST, ASC ( MID$ (A$,I,1))
660  CALL OUTCHR
670  NEXT I
680  FOR I = 1 TO 1000: NEXT I: REM  DELAY FOR ECHO OF COMMAND
IN 560 TO CLEAR.
690  POKE LAST,CNV
700  CALL HOTAP
710 UL = 256 *  PEEK (PTR + 1) +  PEEK (PTR)
720  ONERR  GOTO 890
730  PRINT D$;"OPEN ";AF$
740  PRINT D$;"DELETE ";AF$
750  PRINT D$;"OPEN ";AF$
760  PRINT D$;"WRITE ";AF$
770 L$ = ""
780  FOR I = 6144 TO UL: REM   STARTS AT HIMEM+1
790 C =  PEEK (I)
800  IF C <  > 13 THEN L$ = L$ +  CHR$ (C): GOTO 820
810  PRINT L$:L$ = ""
820  NEXT I
830  PRINT D$;"CLOSE ";AF$
840  PRINT D$: GOSUB 920
850  PRINT D$;"CATALOG": PRINT D$
860  PRINT "PRESS ANY KEY TO CONTINUE."
870  GET C$
880  GOTO 150
890 BOO =  PEEK (222)
900  PRINT "ERROR NUMBER ";BOO;" OCCURRED."
910  GOTO 830
920  PRINT : INVERSE : PRINT "END OF TRANSFER.": NORMAL : PRINT
: RETURN
930  DATA  173, 145, 192, 41, 128, 240, 17, 32, 56, 144, 173,
144, 192, 32, 63, 144
940  DATA  9, 128, 32, 240, 253, 32, 51, 144, 44, 0, 192, 16,
227, 173, 0, 192
950  DATA  44, 16, 192, 201, 148, 240, 55, 32, 74, 144, 141,
109, 144, 32, 95, 144
960  DATA  76, 0, 144, 169, 96, 76, 58, 144, 169, 160, 164, 36,
145, 40, 96, 201
970  DATA  97, 144, 6, 201, 123, 176, 2, 73, 32, 96, 201, 157,
208, 3, 169, 91
980  DATA  96, 201, 136, 208, 3, 169, 127, 96, 201, 149, 208,
2, 169, 9, 96, 173
990  DATA   145, 192, 41, 1, 240, 249, 173, 109, 144, 141, 146,
192, 96, 0, 169, 24
1000  DATA  133, 255, 160, 0, 132, 254, 174, 109, 144, 169, 13,
141, 109, 144, 32, 95
1010  DATA  144, 32, 164, 144, 32, 164, 144, 201, 26, 240, 22,
224, 0, 240, 3, 32
1020  DATA  63, 144, 145, 254, 9, 128, 32, 240, 253, 200, 208,
232, 230, 255, 76, 132
1030  DATA  144, 132, 254, 96, 173, 145, 192, 41, 128, 240,
249, 173, 144, 192, 96
1040  FOR PLACE = TERMA TO TERMA + 175 - 1
1050  READ X: POKE PLACE, X
1060  NEXT PLACE
1070  RETURN
1080  REM  (C) 1981 by  Tom Gabriele
```

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Text continued from page 414:

available to the next program to be run. (Before terminating TAFT operation, you should remember to sign off or log off the host computer.)

Understanding TAFT

Discussion of the program in listing 1 is divided into four parts:

- Initialization of constants and POKEing the machine-language code into high memory
- Terminal mode
- File transfer from Apple to host computer
- File transfer from host computer to Apple

The Applesoft BASIC statements used to implement each of these four parts are described next so you can master the programming techniques used and modify TAFT to your own needs (see listing 1).

Initialization

Line 70 causes the TAFT program to be stored below memory location 6144. This insures that locations at and above that address are free to hold the machine-language code and the file-transfer receive buffer. Should the user make any significant additions to TAFT, it is necessary to increase the number of the memory address, in this case, 6143. For convenience, that number should always be one less than an even multiple of 256 (in this case, 6143 = 24 × 256 − 1). If this number is changed, two other constants in lines 780 and 990 must also be changed. The lower limit of the FOR . . . NEXT loop in line 780 must be the even multiple of 256; in this case, 6144. The last number in the data statement in line 990 must be the integer multiplier of 256; in this case, 24.

Symbol Table

SLOT	$01	INPORT	$C090
STATUS	$C091	OUTPRT	$C092
CH	$24	BASL	$28
PTRLOW	$FE	PTRHI	$FF
START	$9000	DOWN	$9018
UNFLSH	$9038	INCONV	$903F
MSBLAB	$9010	FLASH	$9033
ENDOUT	$905E	OUTCON	$904A
LAST	$906D	OUTCHR	$905F
FLDWN	$903A	ENDINC	$9049
DELETE	$9051	TAB	$9058
HOTAP	$906E	INCHR	$90A4
CLOOP	$9084	ENDHST	$90A1
		NOCONV	$9092

Table 2: *Symbol table for listing 2, showing subroutine labels and their assigned locations in memory.*

Line 80 defines the memory address where the machine-language portion of the file-reception section stores the address of the last character received. The address is held in the receive buffer for later use by its Applesoft portion. This 2-byte character address is stored in the two highest memory locations in page 0 of Apple memory, locations 254 and 255 (see table 1 for all TAFT variables).

Line 90 initializes control-character variables. CZ$ contains a Control Z character, which is used as an end-of-file character. This is a very common convention. In the unlikely event that your host computer requires a different end-of-file character, simply change the "26" in this statement to the decimal equivalent of the alternate control character (once its most significant bit is set to zero).

Line 100 defines the address of the machine-language subroutine used to output a character on the serial communication line.

Line 110 defines the address of the character to be output by the machine-language subroutine located at OUTCHR. To send a character, TAFT simply POKEs the character's ASCII code into location LAST and CALLs OUTCHR.

Line 120 defines the CALLing address of the host-to-Apple machine-language subroutine, HOTAP. This address is located immediately after the 1-byte character buffer LAST.

Line 130 defines the calling address of the terminal-mode machine-language subroutine TERMA. The machine-language code stored at (and above) this address contains references to its own location and is therefore said to be *nonrelocatable*. This means that the machine code cannot be moved in memory and that the values of TERMA, OUTCHR, LAST, and HOTAP defined in this line and previous lines cannot be changed without major modifications to lines 930 to 1030.

Line 140 calls the Applesoft subroutine to store machine-language code.

Lines 920-1030 contain the 175 decimal equivalents of machine-language code to be stored in sequential memory locations. To change the character to exit from the terminal mode, you must change the "148" in line 950. To determine the new value, turn to page 7 of your Apple II Reference Manual and consult the table listing all Apple keys and their associated ASCII codes. The "$" before each two-character entry means that each code is given in hexadecimal notation, so a conversion from hexadecimal to decimal is required. For example, the Control T entry is "$94". Take the more significant character, multiply it by 16, and add the less significant character to that product. In this example, 9 × 16 + 4 = 148. This is the origin of "148" in line 950. Those interested in 6502 assembly language can review the assembly-language listing of the program that produced these 175 values (see listing 2). The listing is thoroughly commented, so even if you have no assembly language experience, you should be able to follow what the machine-language portion of TAFT is doing. This program uses ROM-based subroutines at high addresses in Apple memory to do such things as display a character on the Apple screen. (A complete listing of the contents of this ROM-based monitor begins on page 155 of the Apple II Reference Manual.)

For TAFT to use it, the serial I/O board must be installed in slot 1 of the Apple. If the slot is already in use, five values must be changed in these data statements to permit installation of the serial board in another slot. Add 8 to the slot number that you wish to use and multiply that sum by 16. (In the case of slot 1, this final product is 144.) The new value must replace the 144 near the end of statement 1030 and the 144 in statement 930, between the 173 and the 192. Add 1 to the product computed above. This new value must replace 145 in statements 930 and 1030. Finally, add 2 to the product com-

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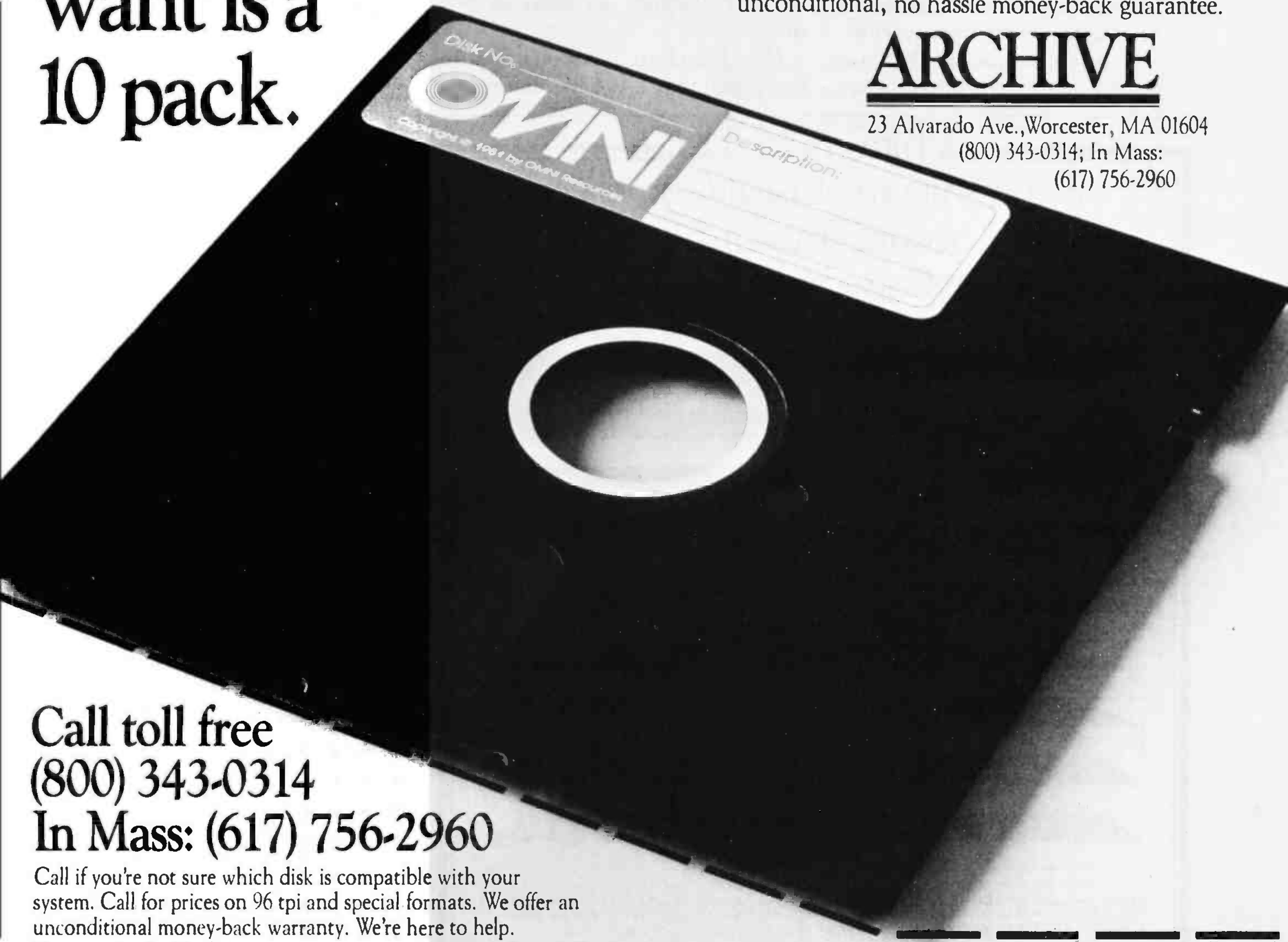

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puted above. This new value must replace 146 in statement 990.

Lines 1040-1060 store the 175 machine-language bytes that were defined in lines 920-1030. Note that the lower limit of the FOR . . . NEXT loop begins POKEing bytes at the exact address defined in line 130.

Terminal Mode

Most host computers automatically echo every character when operating in a full-duplex communication link. That is, each character the host receives from a terminal is returned to that terminal to verify that it was received correctly. In the terminal mode, the echoed character is displayed so that you can monitor the development of any communication problems. This process happens so quickly that you don't realize the interchange has taken place. The TAFT terminal mode is written entirely in machine language to keep any delay, from key depression to character display, as short as possible.

Line 150 clears the screen and informs you that TAFT has entered the terminal mode.

Line 160 transfers control to the machine-language terminal subroutine that was POKEd into memory.

Lines 170-180 determine if you want to transfer a file from the Apple to the host computer. If so, these lines transfer control to the transmission mode, Part 3 of TAFT. Line 170 executes upon return from the machine-language terminal subroutine. This return is caused by keying a Control T.

Lines 190-200 determine if you want to transfer a file from the host computer to the Apple. If so, they transfer control to the reception mode, Part 4 of TAFT.

Lines 210-220 determine if TAFT operation is to be terminated. If not, control reverts to the terminal mode in Part 1 of TAFT.

Line 230 resets the upper memory limit available to Applesoft (see pages 141-142 of the DOS manual).

Lines 240-250 politely terminate the program.

Transmission Mode

Line 260 requests the name of the Apple disk file to be sent to the host and stores it as AF$.

Line 270 requests the name for the new file to be created on the host disk and stores that name as VF$.

Line 280 composes the host-compatible command to create a file on the host disk, with the name specified in VF$. The command is stored as A$. (This line will probably have to be changed to use TAFT with a host other than a VAX-11. Most hosts will have a simple command for creating a disk file and then accepting input from the terminal. In this case, the VAX command CREATE is followed by the specified file name and a carriage-return character. If your host computer does not use the term CREATE, then adapt line 280 to your own host system by using the appropriate host command as the first part of A$.)

Lines 290-320 send the host command (composed in line 280) to the host computer. The FOR . . . NEXT loop successively stores each command character in the 1-byte charac-

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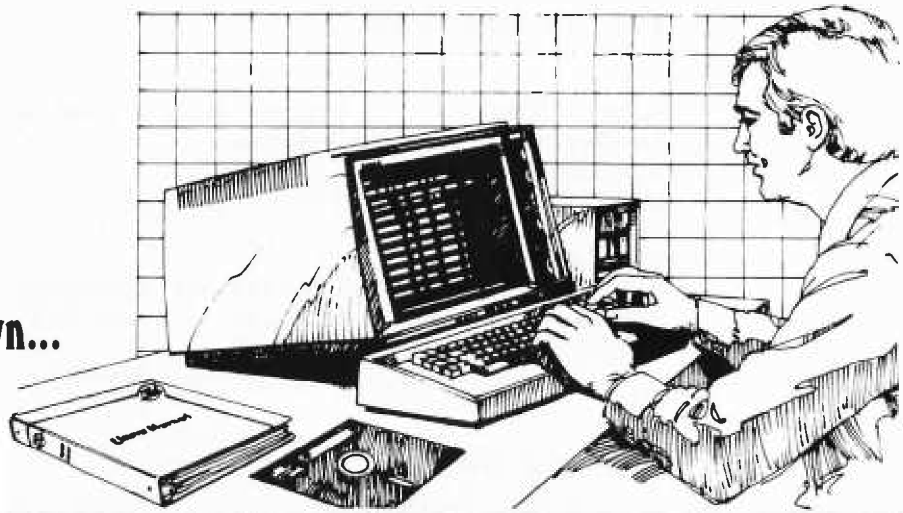

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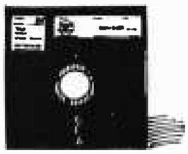

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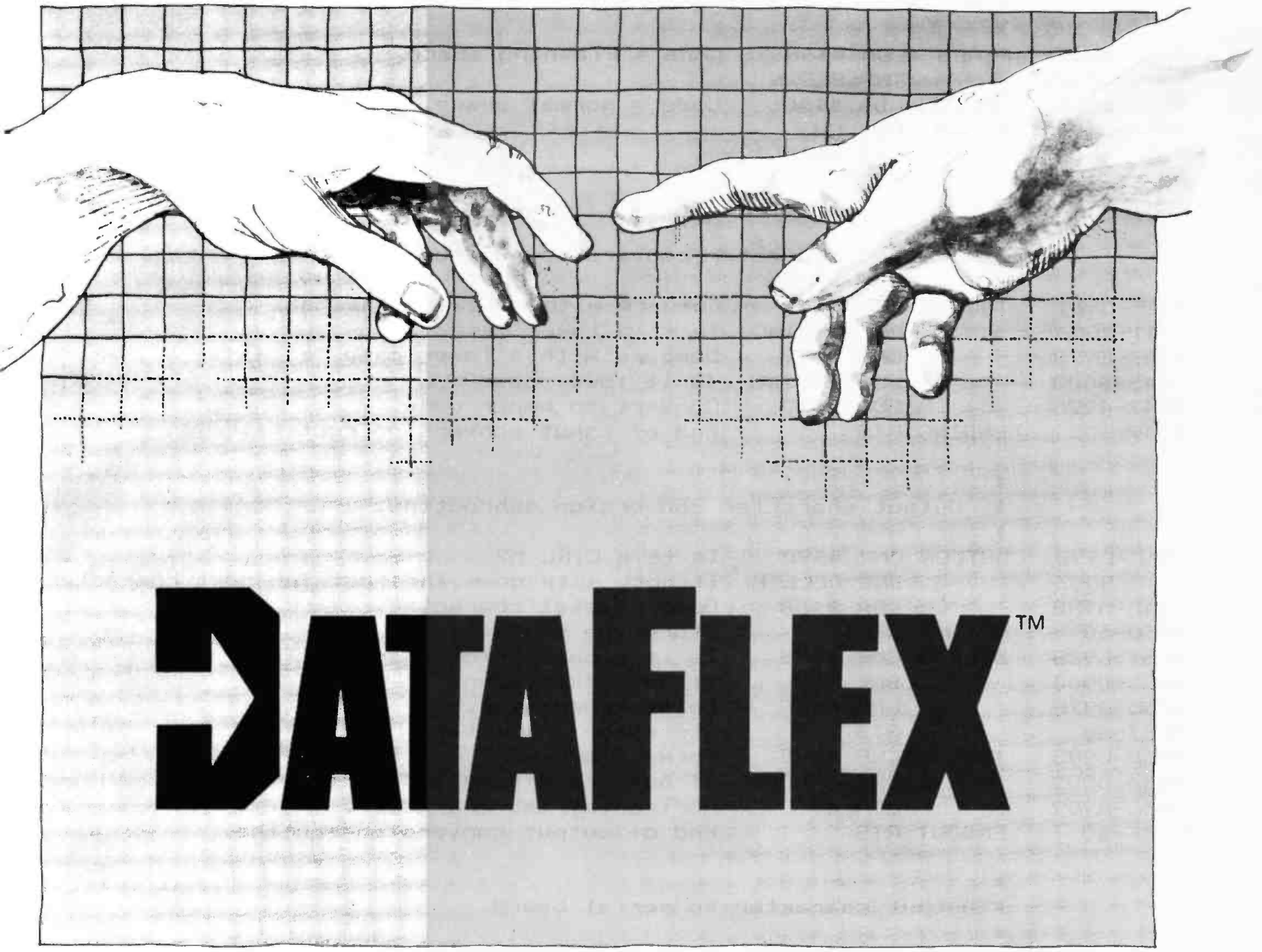
Listing 2: *The 6502 assembly-language portion of TAFT. This 175-byte listing corresponds to the data in lines 930 to 1030 (see listing 1).*

```
            *
            *  Assembly Language Portion
            *  of the Apple Terminal  Program
            *  with Bidirectional File Transfer
            *
            * written by Thomas L. Gabriele
            *
            *    15 JUNE 1980
            *

            SLOT   EQU 1      Serial board slot number.
            INPORT EQU SLOT*$10+$C080
            STATUS EQU INPORT+1
            OUTPRT EQU STATUS+1
            CH     EQU $24
            BASL   EQU $28
            PTRLOW EQU $FE    LS byte of address
            PTRHI  EQU $FF    HS byte of address

                   ORG $9000  Beginning address

            *
            *  Has a character come in ?
            *
9000-AD91C0 START  LDA STATUS  Read status of slot.
9003-2980          AND #$80    Save only input buffer full bit.
9005-F011          BEQ DOWN    IF BIT=0 Branch

            *
            * A character has been received.
            *
9007-203890        JSR UNFLSH  Remove cursor.
900A-AD90C0        LDA INPORT  Read input port.
900D-203F90        JSR INCONV  Call input conversion subroutine.
9010-0980   MSBLAB ORA #$80    Set the MSB.
9012-20F0FD        JSR $FDF0   CALL COUT1, output.
9015-203390        JSR FLASH   Put up cursor.

            *
            *  Has a character been keyed ?
            *
9018-2C00C0 DOWN   BIT $C000   Go back & read again until  ...
901B-10E3          BPL START    the MSB is set.

            *
            *  Process the keyed character.
            *
901D-AD00C0        LDA $C000   Get the last character keyed.
9020-2C10C0        BIT $C010   Clear keyboard strobe.
9023-C994          CMP #$94    If CTRL T, return.
9025-F037          BEQ ENDOUT  Branch to return to BASIC.
9027-204A90        JSR OUTCON  Call the output conversion subroutine.

            *
            *  Output the character.
            *
902A-8D6D90       STA LAST     Save the character to go out.
902D-205F90       JSR OUTCHR   Call the output routine.
9030-4C0090       JMP START
```

Listing 2 continued on page 426



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Listing 2 continued:

```
                *
                * Manage the flashing cursur.
                *
9033-A960       FLASH  LDA #$60    Code = Flashing space.
9035-4C3A90            JMP FLDWN
9038-A9A0       UNFLSH LDA #$A0    Code = Normal space.
903A-A424       FLDWN  LDY CH
903C-9128              STA (BASL),Y
903E-60                RTS

                *
                * Received character conversion subroutine
                *
903F-C961       INCONV CMP #$61    Compare with a lower case "a".
9041-9006              BCC ENDINC  Is it a lower case?
9043-C97B              CMP #$7B    Compare with a lower case "z" + 1.
9045-B002              BCS ENDINC  Is it lower case?
9047-4920              EOR #$20    Convert to upper case.
9049-60         ENDINC RTS         End of input conversion routine.

                *
                *  Output character conversion subroutine.
                *
904A-C99D       OUTCON CMP #$9D    Is it a CTRL M?
904C-D003              BNE DELETE  If not, skip down and test for next character.
904E-A95B              LDA #$5B    Open bracket character.
9050-60                RTS         Store the character.
9051-C988       DELETE CMP #$88    Is it a back arrow character?
9053-D003              BNE TAB     If not, skip down.
9055-A97F              LDA #$7F    Delete character.
9057-60                RTS         Store the character.
9058-C995       TAB    CMP #$95    Forward arrow?
905A-D002              BNE ENDOUT  If not, skip down.
905C-A909              LDA #9      Horizontal tab character.
905E-60         ENDOUT RTS         End of output conversion routine.

                *
                * Output character to serial board.
                *
905F-AD91C0     OUTCHR LDA STATUS  Read slot status.
9062-2901              AND #$01    Save only output buffer empty bit.
9064-F0F9              BEQ OUTCHR  Poll until buffer empty.
9066-AD6D90            LDA LAST    Get the last character.
9069-8D92C0            STA OUTPRT  Write output port.
906C-60                RTS         End of output routine.

906D-00         LAST   DFB 0       Storage for last character.
                *
                *  Host to Apple file transfer coding.
                *
                *  Initialize assembly lang variables.
                *
906E-A918       HOTAP  LDA #$18    Initialize the buffer pointer high byte.
9070-85FF              STA PTRHI
9072-A000              LDY #0      Reset index register.
9074-84FE              STY PTRLOW  Inititialize the buffer pointer low byte.
9076-AE6D90            LDX LAST    Load the conversion flag.

                *
                *  Send a  carriage return character and disgard the host echo.
                *
9079-A90D              LDA #13     Send carriage return character.
907B-8D6D90            STA LAST
```

Listing 2 continued on page 428

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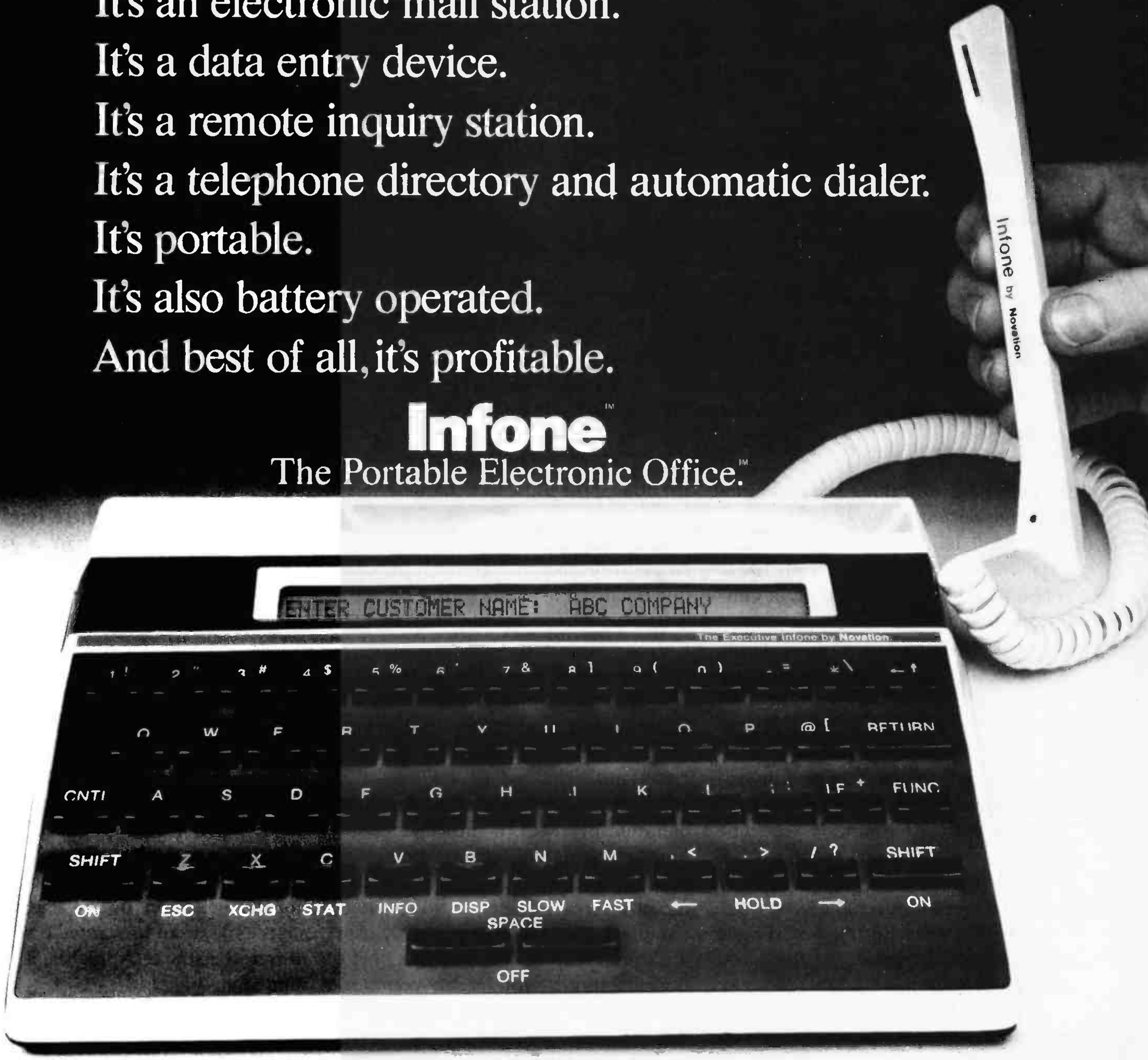

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Listing 2 continued:

```
907E-205F90         JSR OUTCHR
9081-20A490         JSR INCHR   Discard echo of carriage return character.

             *
             *  Character acquisition loop
             *
9084-20A490 CLOOP   JSR INCHR   Get the next character.
9087-C91A           CMP #26     Is it a CONTROL Z?
9089-F016           BEQ ENDHST  If so, branch.
908B-E000           CPX #0      Case conversion flag set?
908D-F003           BEQ NOCONV  If not, bypass conversion subroutine call.
908F-203F90         JSR INCONV  Convert lower case.
9092-91FE   NOCONV  STA (PTRLOW),Y  Store the incoming character.
9094-0980           ORA #$80    Set the most significant bit.
9096-20F0FD         JSR $FDF0   CALL COUT1
9099-C8             INY         Point to next byte.
909A-D0E8           BNE CLOOP   Get next character.
909C-E6FF           INC PTRHI   Point to next page of memory.
909E-4C8490         JMP CLOOP

             *
             *  End of transmission
             *
90A1-84FE   ENDHST  STY PTRLOW  Save the file length.
90A3-60       RTS

             *
             *  Input character subroutine.
             *
90A4-AD91C0 INCHR   LDA STATUS
90A7-2980           AND #$80    Buffer full bit.
90A9-F0F9           BEQ INCHR   Loop if nothing.
90AB-AD90C0         LDA INPORT  Get character.
90AE-60             RTS
```

ter buffer before calling the machine-language output routine.

Line 330 defines where control is to pass when the end of the Apple file is encountered or if any other error condition should occur.

Lines 340-350 prepare the specified Apple sequential text file to be read.

Line 360 initializes, with a *null string*, a string variable that will buffer (hold) characters sent until an entire line is accumulated. This line will be displayed on the Apple screen with a single PRINT command (see line 440).

Line 370 obtains the next character from the Apple source file.

Lines 380-390 send the ASCII code of that next character out the serial communication line.

Line 400 echoes the entire line to the display if the character just sent was a carriage return.

Lines 410-420 append that character to the string to be echoed and go back to get another character from the source file if the last character was not a carriage return.

Lines 430-450 echo the line to the Apple II display and go back to redefine the disk file as the source of characters asked for by the GET in line 370.

Lines 460-480 send a Control Z character as the end-of-file indication to the host computer so it will close the new file and stand by for the next command. The use of a Control Z character for this purpose is a fairly common protocol. If, however, your host computer doesn't echo commands typed from the TAFT terminal mode after a transfer to the host is complete, then the host probably uses a different end-of-file character. (The host computer won't echo your terminal-mode commands because it doesn't know that the file transfer is completed and it is putting your terminal commands into that file as well.) If this occurs, find out what character (or sequence of characters) should be used as the end-of-file marker, then modify these lines appropriately. If more than a single character is required, you can use a construct similar to the one contained in lines 290-320.

Line 490 calls the one-line subroutine that displays the TRANSFER COMPLETE message.

Line 500 delays a moment.

Line 510 transfers control back to the terminal mode.

Line 520 begins error-handling routine by saving the error code in variable BOO.

Line 530: whether the error was a normal detection of the end of the source file or an unwanted error condition, the source Apple file is closed immediately.

Line 540: if a normal end-of-source-file condition was detected, transfer control to the code that sends the end-of-file marker.

Lines 550-560: if it wasn't a "normal" error condition, you are in-

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formed which error occurred before TAFT transfers to the end-of-file marker code.

Reception Mode

Line 580 requests the name of the host source file to be sent to the Apple and stores it as VF$.

Line 590 requests the name of the new Apple file to be created and stores that name as AF$.

Lines 600-620 ask you if you want conversion of lowercase characters to uppercase and stores your decision in variable CNV.

Line 630 composes a command to the host computer to send the contents of the file (specified in VF$) followed by a Control Z (end-of-file marker) and stores that command as A$. This is the second and last TAFT statement that is VAX-11 host-specific. For a different host, this statement must be changed. If your host computer automatically sends an end-of-file character other than a Control Z, simply change the "26" in the data statement in line 1010 to the decimal equivalent of the control character your host uses. TAFT will then look for this character as the end-of-file marker. Unlike the host command composed in line 280, this command is not terminated with a carriage-return character. The following explains why.

Lines 640-670 send the host command composed in line 630 to the host computer.

Line 680 waits for the echo of the command characters, sent by lines 640-670, to return from the host. You don't want to begin accumulating characters for the new file too quickly or you will find the host echo of the command characters at the beginning of that file. Since a carriage return has not yet been sent, the host will not perform the command (that is, send the file). Therefore, this delay will not cause us to miss any file contents.

Line 690 informs the machine-language subroutine whether the lower-to-uppercase conversion is to be performed (see lines 600-620).

Line 700 transfers control to the machine-language subroutine, HOTAP, for file reception. After setting up the address pointers used to store incoming characters in the receive buffer, HOTAP sends the carriage-return character to the host computer to complete the command. Because HOTAP is a fast machine-language routine, it readily receives and stores characters as they come from the host.

One final subtlety is that after sending the return character, HOTAP ignores the *first* character coming from the host—the echo of that return character. All characters that follow will be saved in the receive buffer. This procedure is relatively time insensitive, and should work on any host. Finally, HOTAP stores the 2-byte address of the last character received at PTR and PTR+1, which is used in the next line.

Line 710 computes the address from the two binary bytes previously stored by HOTAP and re-stores this address in the Applesoft variable UL.

Line 720 defines where program

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•68000•	S150 WS 1-user	8,450
	256K RAM, 10MB hard disk, 960KB floppy CRT, OS + 1 language	
	S150-3 WS 3-users	10,800
	same as S150 WS	
	S150-6 WS 6-users	12,800
	512K RAM same as S150 WS	
	Graphics 300 × 400	900
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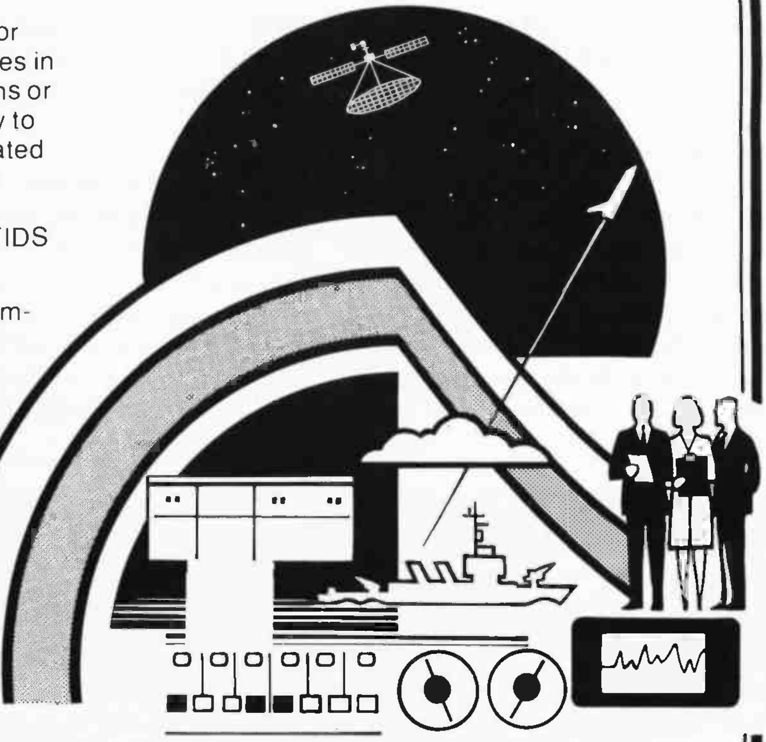

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control is to pass if an error occurs *while* storing the new file on disk.

Lines 730-760 prepare the sequential text file to be written on the Apple disk, using the name you specified. Any other disk file with this name will be overwritten.

Line 770 initializes (to the null string) a string variable that will be used to write an entire line of text to the disk.

Lines 780 and 820 create a FOR. . .NEXT loop to process each character stored in the receive buffer, at addresses beginning at HIMEM+1 and going up to the address computed in line 710.

Line 790 gets the next character from the receive buffer.

Line 800: if this character is not a carriage return, then the line of text is incomplete. Therefore, this statement appends it to the string being composed and passes control to line 820, which returns for the next character.

Line 810: if the character was a carriage return, then the line of text is complete. This statement writes it to the new disk file and reinitializes the composing string variable L$ to the null string.

Line 830 closes the new Apple file.

Line 840 temporarily stops disk operations and gives you a prompt indicating the end of a valid transfer.

Lines 850-880 display a catalog of disk files (to show the new file just generated) and wait for you to press any key to re-enter the terminal mode.

Lines 890-910: in the event of an error, this section displays the error number before closing as much of the new file as was written to that point.

Whys and Wherefores

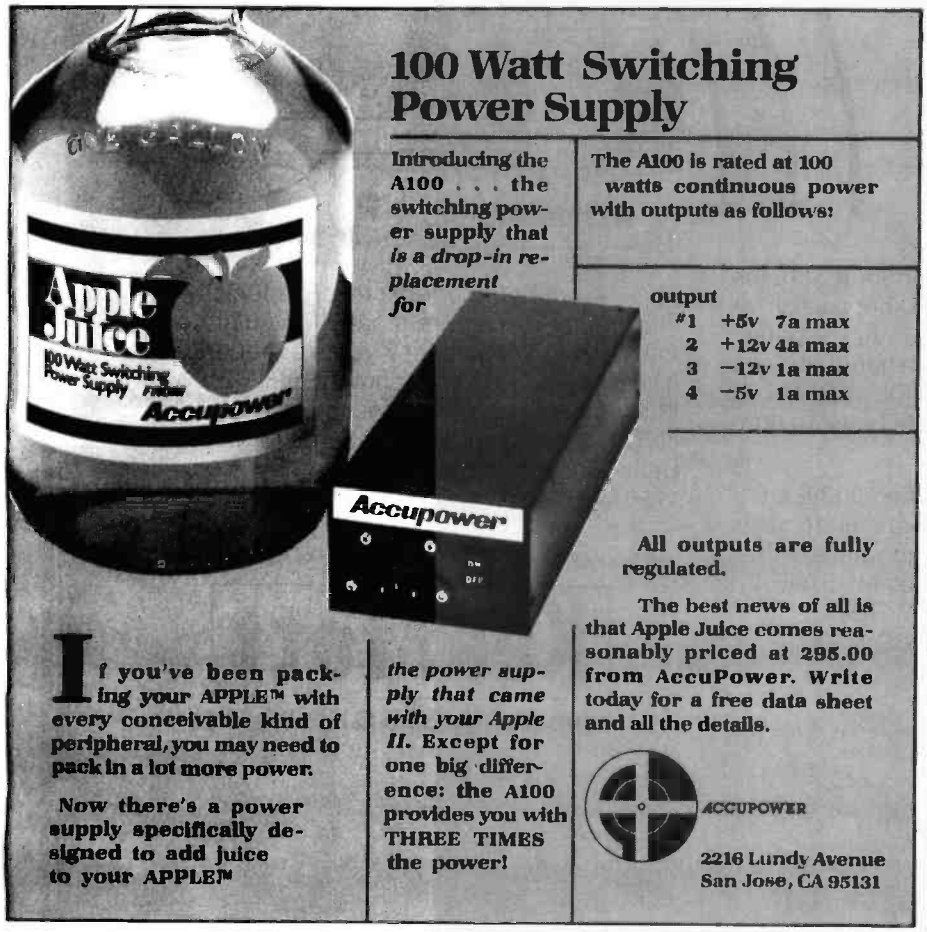
As our society becomes increasingly computer-based, the home that can access the computer at the bank, store, or library will be the home that gets the best service. TAFT can be the first step toward ensuring that you have access to these new services.

Commercially, TAFT can form the basis for many profitable home activities. Although the processing power of host computers surpasses that of an Apple II, the smaller computer has the advantage of more cost-effective peripheral devices. In other words, although a large computer can process much data rapidly, the Apple II is better equipped to display the answers to people and to get their responses.

For example, the host computer may have a number of alternate solutions to a problem in bus routing, stock ordering, plant layout, or molecular structure. Using its graphic-display capability, the Apple II could present these solutions in a manner more easily understood than pages of printout. You could communicate your selection or "grading" of the host output back to the host computer for further processing or final output. Through its own processing and disk storage, an Apple II with terminal and file-transfer capability can make the most efficient use of a mainframe's computer time.

The most obvious commercial use of TAFT would be as a *data capture* station. Consider moving traditional keypunch operations to your home. The Apple would capture the data (i.e., make it machine readable) and communicate that data, using TAFT, to the customer's host computer. An Apple with a text editor becomes an off-line, key-to-disk system. Or the more exotic input devices of voice input or graphic tablet could be used to efficiently capture the data. Regardless of the exact functions, TAFT allows you to deliver the output data product directly to the client computer.

Some may find these ideas impractical—others do not. Alvin Toffler devotes a chapter of his recent book, *The Third Wave,* to the emerging trend of "electronic cottage industries" where workers "telecommute" with their employers. As usual, individual entrepreneurs will spearhead the initial exploration of these new modes of providing service. Perhaps TAFT can help you and your Apple II "catch the wave." ■



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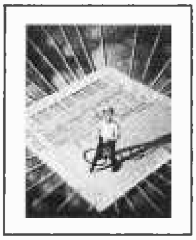
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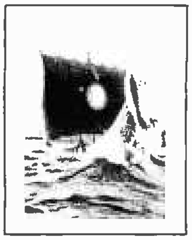
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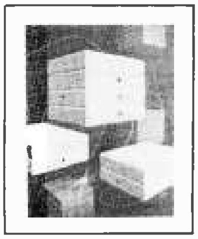
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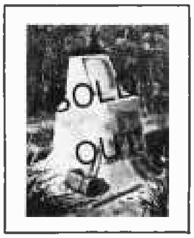
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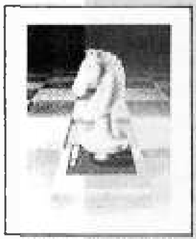
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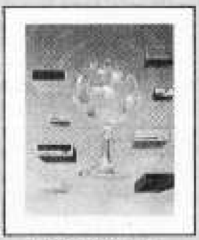
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ALSO AVAILABLE are the prints shown at left. "Computer Chess" is an 18" X 22" full color poster.

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Signals Got Crossed

Dear Steve,

I am currently using a Soroc IQ-120 terminal with a North Star system. What would it take to hook up a "slave display" (without a keyboard) to the Soroc so that I can monitor what's happening from a few yards away?

I've tried connecting a Motorola composite-video monitor to the Soroc's auxiliary port, and I have tried the same thing with an Amdek 100, with sorry results. I have tried connecting these monitors in parallel with the Send and Receive lines coming out of the computer (one at a time, that is), and all I could get was a screenful of black-and-white lines. Obviously, something is not being translated correctly.

According to Soroc technicians, any composite video monitor should work when connected to the auxiliary port (of course, a CHR$(27) +CHR$(64) must be included in the beginning part of the program being run to set up the IQ-120 so that the auxiliary port is on). Well, it doesn't work.

Can you tell me if this is due to a program error, or do I need additional hardware to modify the system, or is it simply impossible? Have I been wasting my time and money accumulating useless monitors?

N.B. Sadorian
Montebello, CA

The Soroc IQ-120 is designed to take an RS-232C serial-input signal and convert it to characters that are displayed on the screen. To do this, it takes the serial input, converts it to parallel, and stores it in memory. Then, using a character generator and shift register, it generates the bit stream that forms the characters on the screen. It's after this stage that a composite-video signal (made up of data and horizontal- and vertical-sweep information) is generated.

This signal is what is fed to the monitor portion of the terminal. To use a "slave" monitor, it would have to be connected after the shift register.

You are confusing the RS-232C data input with a composite-video signal. The auxiliary port is used to attach a printer or modem to the terminal and to provide serial digital data, not a composite-video analog signal.

Since you already have a monitor, get a video board that will take the RS-232C input and generate the composite-video output. (One such board is available from Standard Microsystems Corp., 35 Marcus Blvd., Hauppauge, NY 11788, 516 273-3100.) This board can be

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connected to the Soroc's auxiliary RS-232C port and the board output connected to the slave monitor. . . . **Steve**

A Shifty Problem

Dear Steve,

I have a 48K-byte OSI (Ohio Scientific) C4P DMF computer that can produce lowercase characters. It serves my purposes very well, except for one annoying feature: the shift-lock on the keyboard.

From time to time, I use a typewriter as well as the computer, so the fact that the two machines have substantially different keyboard layouts is a great inconvenience. I produce all my correspondence on the computer using a word-processing program, which is much to my liking. But a problem arises when I try to program in BASIC: I cannot conveniently enter text that has lowercase characters, because the fingering is wrong.

I see no need for the two shift keys to be independent and dissimilar in function. The shift-lock should be an all-caps keys. It should only "unlock" the alphabetic keys. Has anyone attacked this problem? Do you know of any way I can get relief from this problem?

Carl M. King
Sarasota, FL

I do not know an easy solution to your uppercase/lowercase problem with the OSI C4P computer. The most practical solutions are:

- *Rewrite the keyboard routine. This is located in ROM (read-only memory) at location hexadecimal FD00. This would require installing a new PROM (programmable ROM).*
- *Use an auxiliary keyboard and attach it through the parallel-input port that normally reads the existing keyboard. This, too, will require a software driver to function properly.*

I would vote for the second method as the lesser of the two evils. . . . **Steve**

One-Alarm Question

Dear Steve,

I have an application that requires a low-power audible alarm. What I need is the type of alarm that's found in an electronic watch or calculator, but I don't want to destroy a watch to get one. Can you help me find a source for them?

Brian Gravenhorst
Chicago, IL

Here is a list of manufacturers that make miniature audible alarms. While none are designed to fit into a watch, they are quite small and consume little power. I hope this solves your problem. . . . **Steve**

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The End of 8-Bit Epoch?

Dear Steve,

I'm thinking of getting a microcomputer so that I can write and sell software. However, since IBM has introduced a 16-bit computer, and I had planned to buy an 8-bit Atari 800, I fear that Atari will follow IBM's lead and replace the 800 with a 16-bit computer after I make my purchase. Then I will own an outdated piece of junk. Do you know if Atari is about to convert to 16 bits?

Harry Sices
Hanover, NH

The future trend of computers will certainly include 16-bit and possibly 32-bit machines, but 8-bit machines will definitely not become "outdated pieces of junk." Look to the bright side of 8-bit machines:

- *they have been around for several years*
- *virtually every home computer is an 8-bit machine*
- *documentation and software abound for these machines*
- *at least a half million of them are in use*

I doubt that you will see 16-bit computers taking over in the near future, so don't fear buying an 8-bit machine. If your goal is to write and sell software, you will certainly have a larger market with the 8-bit machines. Atari even offers the part-time programmer an advantage, since it will help market good software written for its machine.

At this time, I am not aware of any effort by Atari to market a 16-bit machine, but I assume that Atari may eventually feel market pressures to do so. . . . **Steve**

Sensing Motions

Dear Steve,

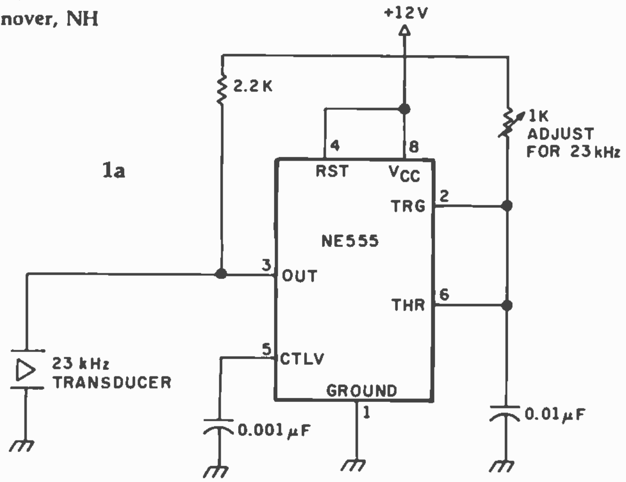
I'm interested in adding sensors to my driveway and connecting them to my security system. In the articles that you've written on security systems, you mentioned that you were using sensors in your driveway. (See "Build a Computer-Controlled Security System for Your Home," Part 1, January 1979 BYTE, page 56; Part 2, February 1979 BYTE, page 162; Part 3, March 1979 BYTE, page 150.) What devices do you use?

I'm planning on installing two sensors about 10 feet apart mounted on split-rail fence posts. (That way I can sense the direction of movement.) I will have to run at least 250 feet of wire from the house to the sensors. The distance from the source to the sensor across the driveway is about 12 feet. Any ideas that you have would be greatly appreciated.

Charles Finn
Fayetteville, GA

I have tried a number of different sensors in my driveway, and I found that the most reliable is a microwave motion-detector combined with an ultrasonic beam that goes directly across the driveway.

I have a fairly long, U-shaped driveway. The ultrasonic transmitter (see



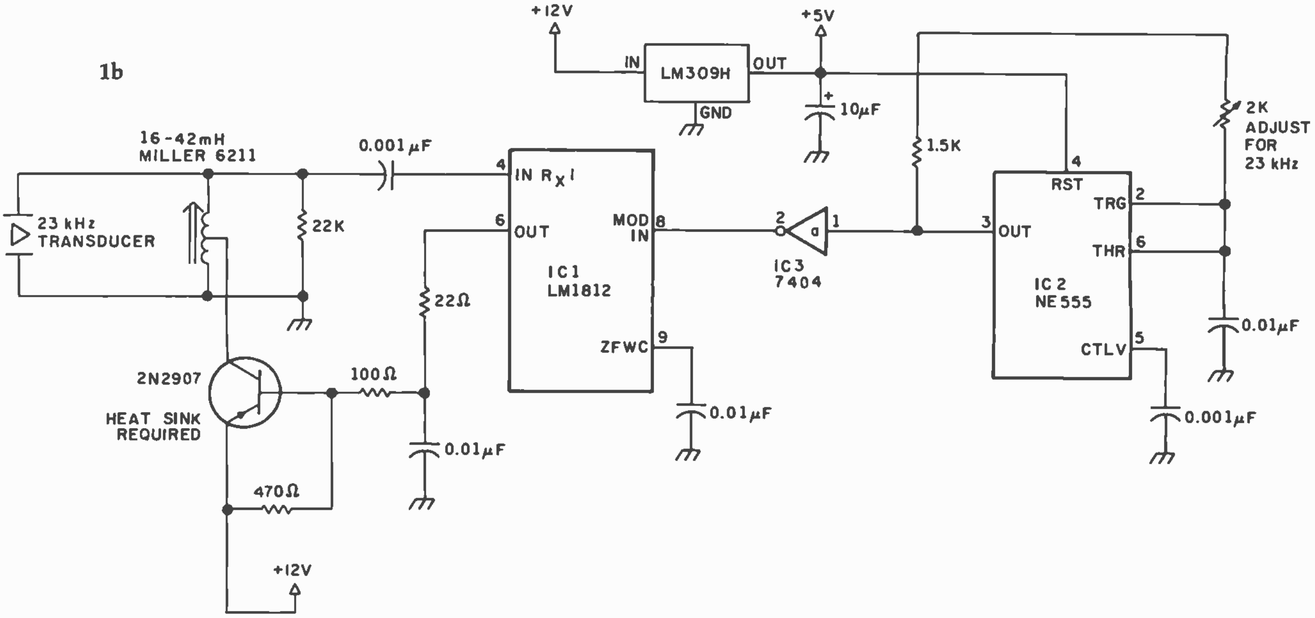


Figure 1: *Ultrasonic transmitters.*

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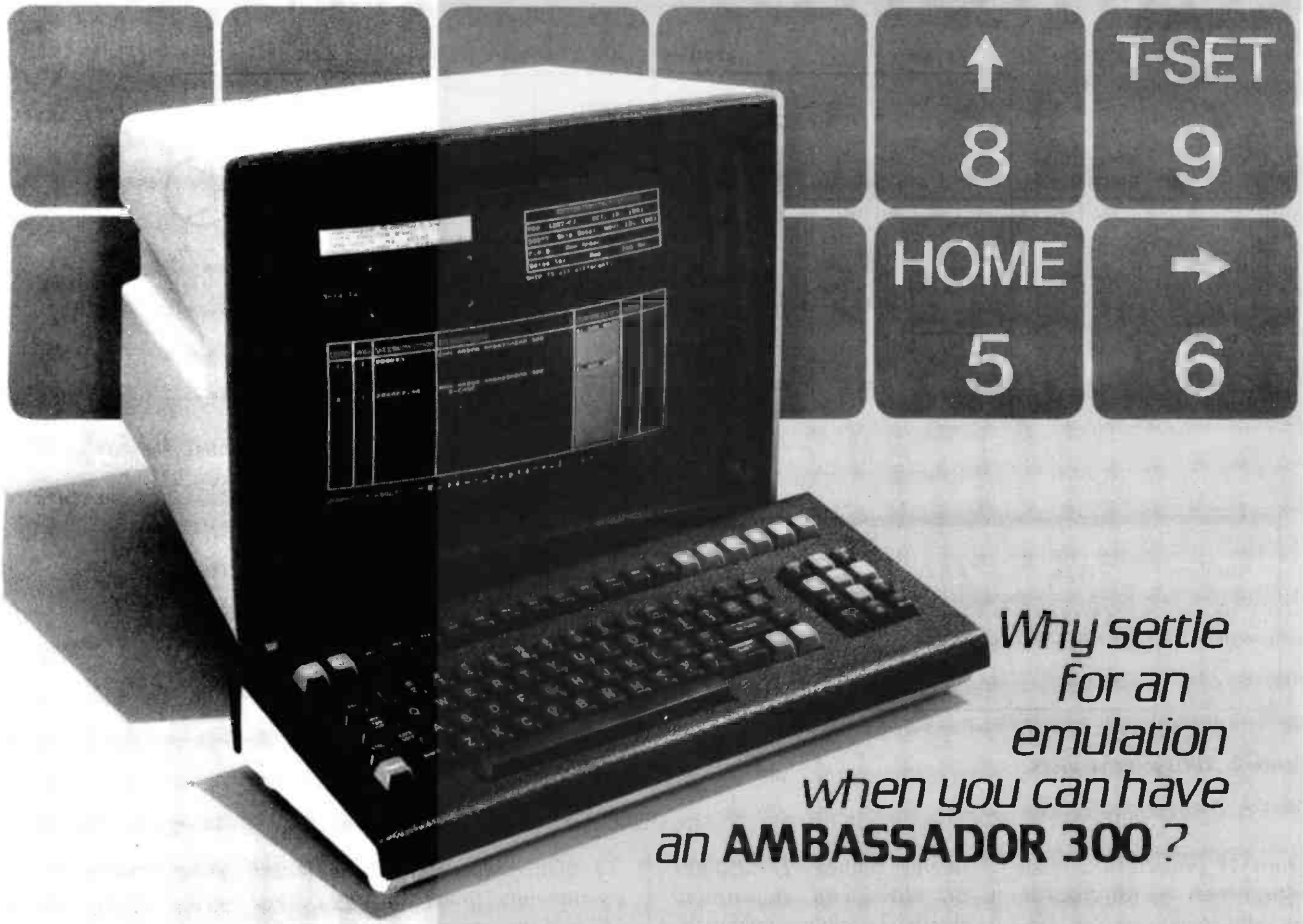

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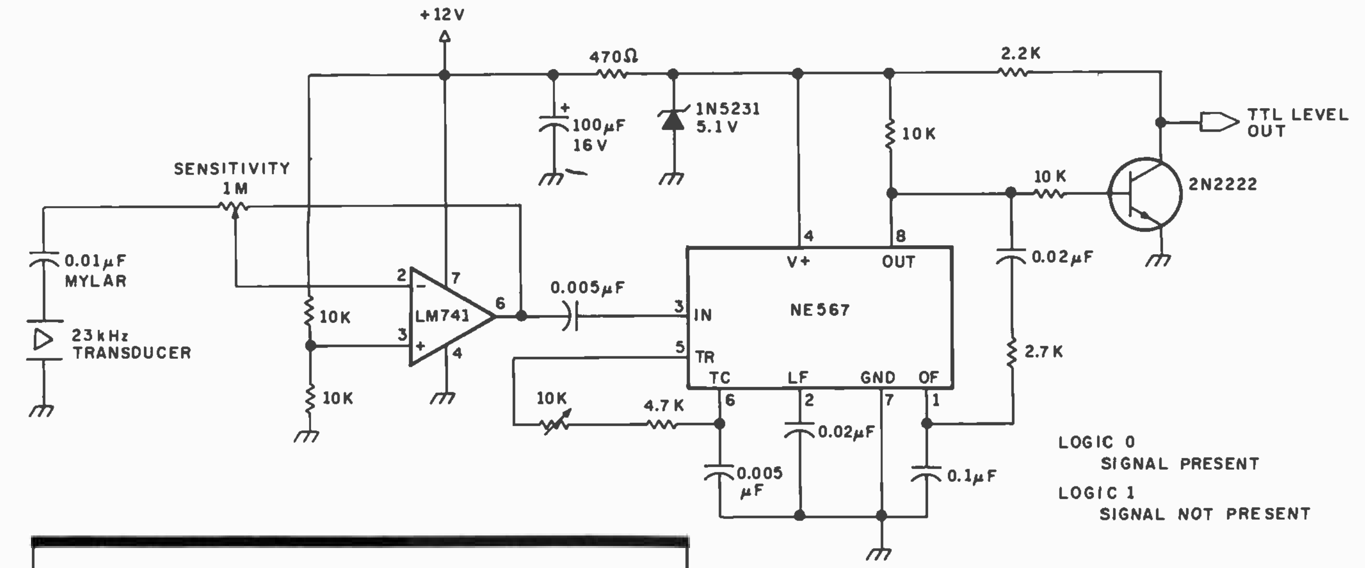

Number	Type	+5V	GND	+12V
IC1	LM1812		5, 10, 15	12
IC2	NE555	8	1	
IC3	7404	14	7	

Figure 2: *Ultrasonic receiver.*

figure 1) projects a 12-foot beam across the driveway to an ultrasonic receiver (see figure 2, above). It has a usable range of about 20 feet. (These are the circuits from my articles.) The transmitter is built into a couple of small, sealed aluminum boxes and mounted across the road. Further down the driveway, where the space opens up, I have a microwave motion-detector. I used microwave because the standard infrared and ultrasonic motion-detectors have too many false alarms. While the microwave units cost much more ($300 or so), their reliability makes up for the difference in price.

In your application, it sounds as though you can use an ultrasonic transmitter/receiver pair aimed across the driveway. When something passes through the beam, the connection is broken and the logic-level output of the receiver changes. The 250 feet of wire you mentioned shouldn't inhibit operation. You may find it advisable to add a level-shifting transistor to the output of the receiver. This will give you a 0- to 12-volt signal, which will be easier to transmit 250 feet.

I'd be interested in hearing from you after it's set up. . . . Steve

A One-Shot Solves All

Dear Steve,

In your article "Build an Intelligent EPROM Programmer" (October 1981 BYTE, page 36), why did you implement the 50-ms (millisecond) programming pulse in hardware instead of using a software loop?

George Kaplan
Spring Valley, NY

I implemented the 50-ms programming pulse on my EPROM programmer in hardware rather than software for simplicity. It was easier for me to add the "one-shot" circuit than to set up a software timing loop (regular readers of the Circuit Cellar will notice a definite tendency toward hardware solutions). However, either method is perfectly satisfactory. If I had used a software timing loop, the write pulse would have been tied to pin 18 through the 74LS04 and 7406 circuits in the same manner that pin 20 of the 2716 was tied (see figure 4b, October 1981 BYTE, page 43). If you take this route, be sure that a constant high level is not applied in the programming mode. The one-shot circuit gives built-in protection against this happening. . . . Steve■

In "Ask BYTE," Steve Ciarcia answers questions on any area of microcomputing. The most representative questions received each month will be answered and published. Do you have a nagging problem? Send your inquiry to:

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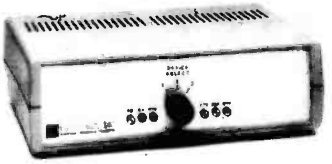

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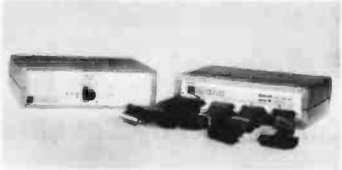

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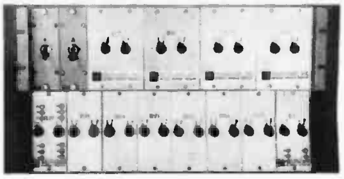

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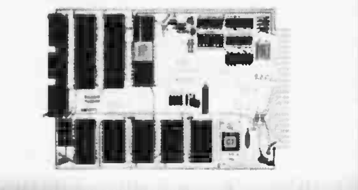

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BYTELINES

News and Speculation about Personal Computers

Conducted by Sol Libes

Random Rumors: Add the following items to the NCC (National Computer Conference) rumor list I gave in last month's BYTELINES: Hitachi is expected to show a personal computer prototype with specifications very similar to the IBM machine. It will use the Intel 8088 processor and will also have three operating systems: MS-DOS, CP/M-86, and Pascal. It should be on the market before year-end. . . . Also expected at NCC is a scaled-down version of the Star work station from Xerox, expected to sell for 50 percent less and to be called (what else?) the Starlet. Incidentally, although the Star was a hit at last year's NCC, I am not aware that any units have been shipped to customers. . . . Other anticipated new entries at NCC include a videodisc-to-microcomputer interface and a videodisc with a 250-megabyte legal database from Xedex, New York, and a 120K-byte, 6809-based multiuser system, with a Unix-like operating system, from Gimix, Chicago, Illinois. . . . Also at NCC you can expect to see at least four manufacturers running Microsoft's Xenix multiuser DOS on their systems.

Look for Panasonic to shortly introduce a $199 personal computer; a color version will sell for $299. Later the firm expects to introduce voice I/O for the unit. Options will include memory expansion, disk drives, joysticks, and an 80-column printer. Software packages will include word processing and business applications under standard CP/M and Apple CP/M. . . . Several IBM look-alikes are expected on the market shortly.

Random News Bits: Digital Research has confirmed what was previously rumored in this column, namely that it is working on a 68000 implementation of the CP/M disk operating system. Hitachi is expected to be the first to use it. . . . Vector Graphic has reported a 156 percent increase in income for the last quarter of 1981—$1 million, up from $395,000 the year before. Sales for the quarter were $9.68 million. . . . Commodore reported that its net income rose 63 percent on a sales increase of 55 percent for the second half of 1981 ($124 million). . . . Diablo reportedly will shortly begin making video-display terminals. . . . Cromemco, Mountain View, California, has disclosed that it is working on a 2-megabyte S-100-card memory, designed primarily for its new 68000 system. With just eight cards, the user can have 16 megabytes of directly addressable memory! . . . G & G Engineering, San Leandro, California, has introduced "IBM-ulator" for S-100 CP/M systems. Using an 8088 processor card, the IBM-ulator can read and write CP/M-compatible files from and to an IBM 5¼-inch disk. . . .Later this year Toshiba will introduce a dot-matrix printer with a 24-pin head mechanism capable of producing fully formed characters at 100 characters per second (cps) and draft-formed characters at 160 cps. . . . New England Digital Corporation, White River Junction, Vermont, and Hazelcom Industries Ltd., Toronto, Ontario, have announced machines with piano-like keyboards that transcribe whatever music is played on them.

Marketing Is the Name of the Game: Computerland Corporation has disclosed that it is planning to set up franchised stores that will sell only software. The company's goal is to have 400 software stores open by 1984. . . . Sears is so delighted with the performance of its five computer stores that it will shortly open 45 more in 17 cities. The stores will be known as "Business System Centers" and will employ an expected 300 sales personnel. The Sears stores currently carry IBM, NEC (Nippon Electric Company), and Vector Graphic computer systems, TI (Texas Instruments) and HP (Hewlett-Packard) calculators, Exxon and Olivetti typewriters, Saxon copiers, and Wang word processors.

There is no doubt that success in the personal computing marketplace now is less a function of having a well-designed product than of having adequate distribution. I recently made a brief survey of all the computer stores in the 10 largest U.S. cities to determine system distribution. I checked Boston, Chicago, Dallas, Detroit, Houston, Los Angeles, New York, Philadelphia, San Francisco, and Washington, DC., and I discovered that in these cities a total of 165 computer stores were carrying 37 different makes of computers. Ranked in order, the 20 leading systems and the number of dealers for each system were: Apple, 120; Atari, 60; HP, 43; IBM, 38; Commodore, 37; Vector Graphic, 35; Radio Shack Computer Centers, 34 (full-line stores not included); Cromemco, 30; TI, 21; North Star, 18; Dynabyte, 18; Data General, 16; DEC (Digital Equipment Corporation), 15; Zenith, 15; and Altos, 15.

Some interesting conclusions can be drawn. First, Apple is far and away the most popular with dealers, probably due to the large amount of advertising done by Apple that, in effect, presells the system for the dealer. Second, most of the leading systems are made by large companies to whom computers are only a small part of the total business. Most of the companies that grew out of garages, so to speak, are now only a small part of the industry. Third, none of the Japanese suppliers has yet achieved acceptance from computer stores. I found only six dealers who carried the NEC system, and only one carried the Sharp system.

Integrated Circuits: Fujitsu has disclosed that it will shortly begin providing samples of a 64K-bit CMOS EPROM (erasable programmable read-only memory). . . . DEC will soon start supplying the integrated circuits used in its base-level PDP-11 machines. . . . Motorola is making final plans to introduce the MCM2816, an EEPROM (electrically erasable programmable read-only memory) that will be a pin-for-pin replacement for the popular 2716 EPROM. The company will follow this shortly with a 32K-bit version. The days of the ultraviolet

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EPROM eraser appear to be *numbered*. . . .

IBM News Items: Software Techniques, Alexandria, Virginia, has published a report that provides engineering data on the custom integrated circuits and proprietary devices used in the IBM Personal Computer system. It includes schematics, parts lists, timing diagrams, etc., not provided by IBM in its documentation. The report costs $5000. . . . Xedex Corporation, New York, has introduced a plug-in Z80 processor card with 64K bytes of memory (similar to the Microsoft Softcard for the Apple II) that allows an IBM Personal Computer to run CP/M-80 software. The price is $600. Xedex hopes that IBM users will take advantage of this until there is a decent amount of software available for the IBM system. . . . IBM is expected to open soon a Personal Computer manufacturing plant in France. . . . Several Computerland stores are reportedly offering quantity discounts on the IBM Personal Computer. . . . Corvus Systems, San Jose, California, is rumored to be working on a networking system for the Personal Computer that should be available later this year. . . . Several C compilers for the Personal Computer are due for release this summer.

IBM has also introduced a robot, called the 7535 Manufacturing System, that can be programmed using an IBM Personal Computer system with a special version of IBM's new robotics language called AML (A Manufacturing Language). The robot is built in Japan and will cost $28,500. The program costs $5575. IBM is also test-marketing the RS-I robotic system, which has an arm that can move in six directions and a two-fingered hand. The RS-I is presently being used to assemble IBM computers.

Apple Happenings: Microsoft's Z80-based processor card for the Apple III will be marketed exclusively through Apple Computer Inc. Microsoft disclosed that 20 percent of all Apple IIs are using the company's Softcard with CP/M. . . . Franklin Computer Corporation, Pennsauken, New Jersey, has introduced a computer that is compatible with the Apple II. The machine will do everything the Apple II does except display color graphics (that would infringe on Apple patents). The Franklin computer, however, has extra keyboard functions, more memory, and sells for $300 less than the Apple II. I suspect that Franklin should find several mail-order dealers very interested in selling its product. . . . Several imitations of the Apple II are reportedly being made in the Far East. Apple is investigating action against these copiers as the machine is protected by four or five patents.

CP/M News: Digital Research reports that CP/M-80 has now been implemented on over 450 different computer systems. Can there be any doubt that CP/M is the standard for single-user 8-bit disk-operating systems? . . . Lifeboat Associates, New York, has released EM-86, a software module that will allow CP/M-86 software to run under the control of Microsoft's MS-DOS without any modifications. The module costs $75. . . . Dasoft Design Systems, Aloha, Oregon, has introduced a design-automation system called Magic. Running under CP/M, it aids in the design of circuits, documentation, and printed-circuit generation. It includes a design editor, device library, schematic generator, and more. It produces camera-ready artwork and is priced at $729. . . . Virtual Microsystems, Berkeley, California, has introduced a CP/M-80 simulator for DEC PDP-11 and VAX-11 systems. Running as a task under RSTS, RSX, or Unix, it allows the reading and writing of standard 8-inch CP/M disks and the running of CP/M programs.

MS-DOS Versus CP/M: When Microsoft wanted to implement many of its languages and applications packages on the Apple II, the company chose what it considered the easiest, fastest, and most economical way to do it: creation of a "hardware bridge"—a Z80 processor card for the Apple II that allows the running of CP/M-based versions of Microsoft's software.

There is no doubt that CP/M has become the most successful microcomputer DOS. It has the broadest support from language- and application-software suppliers and public-domain software (I challenge anyone to tell me, with any accuracy, how many software packages are currently available for CP/M-based systems). CP/M has been licensed, according to Digital Research, on over 450 different types of systems (this probably translates into over 450,000 actual machines).

Microsoft, with extensive experience in system software development, last year decided to introduce its own DOS, called MS-DOS, naturally (for Microsoft disk operating system). Actually MS-DOS was created a few years earlier by Seattle Computer Products for its 8086-based S-100 system when the company gave up waiting for Digital Research to introduce CP/M-86. Microsoft acquired exclusive rights to the DOS, hired its author and invested a considerable effort in enhancing it.

The battle lines have now been drawn—picture CP/M as Goliath and MS-DOS as David. In just six short months, MS-DOS has gained a strong foothold in the single-user/single-task DOS marketplace. The greatest coup, of course, is the IBM Personal Computer: although IBM has announced three different operating systems for the Personal Computer, at this writing only one is available—MS-DOS. Microsoft has further announced that MS-DOS has already been implemented on 20 different machines and that 32 more (11 of which will be from Japan) should be announced by year-end. In other words, MS-DOS will have been implemented on over 50 machines by the end of 1982.

Microsoft took a close look at CP/M—its strengths and particularly its weaknesses—in developing MS-DOS. There is little doubt that the firm has created a DOS that is much more user-friendly, faster, with many more advantages, and fewer disadvantages than CP/M.

One of MS-DOS's biggest disadvantages appears to be the lack of a floppy-disk-format standard that allows users of different systems to exchange disks. One of CP/M's greatest advantages is that software vendors can supply CP/M software on 8-inch single-density soft-sectored disks and cover most of the CP/M marketplace (although the increasing popularity of 5¼-inch disks is becoming a problem). Microsoft is attempting to convince its MS-DOS original equipment manufacturers that a 5¼-inch disk format is important. With IBM's help the 5¼-inch format may become

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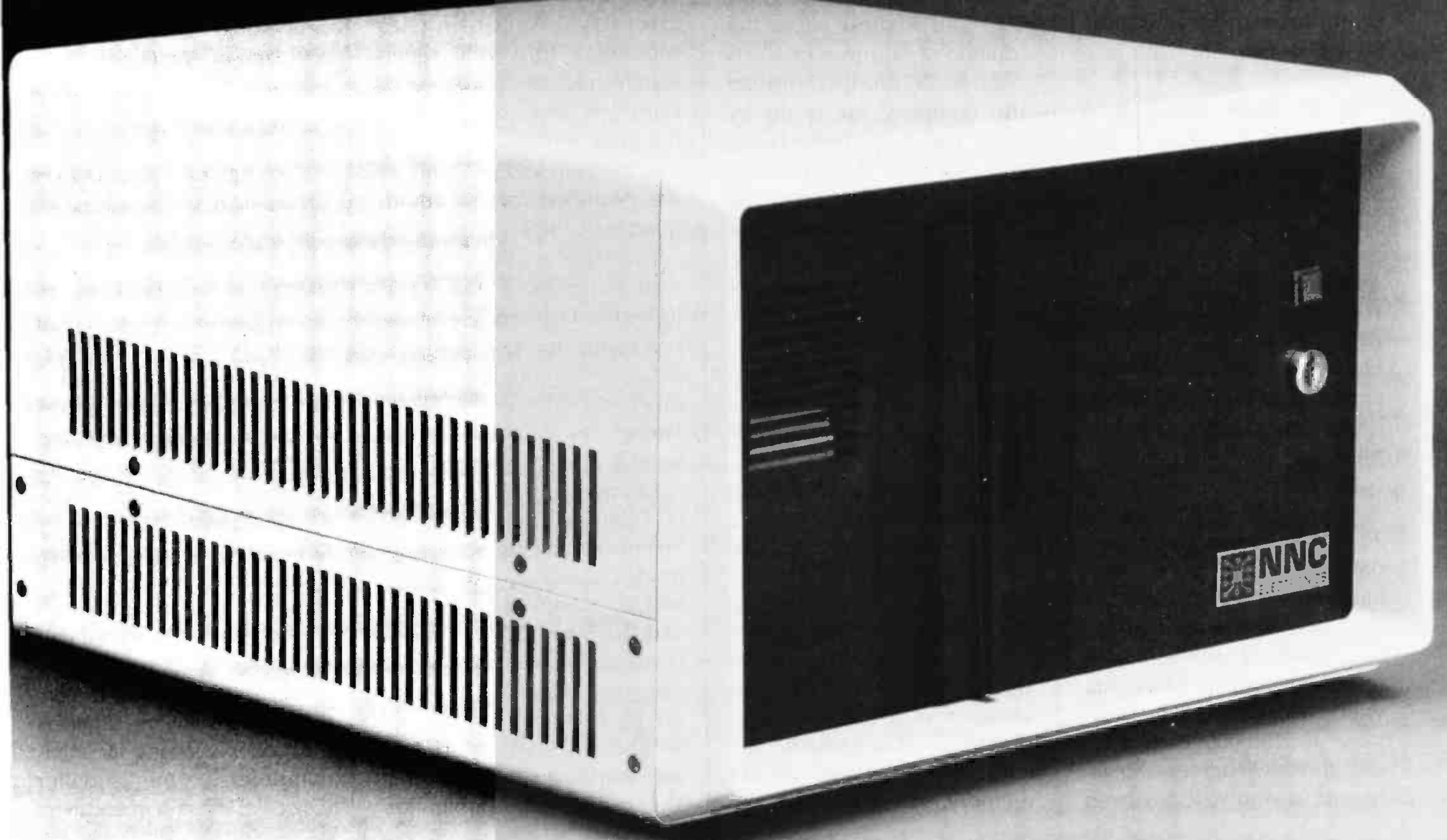

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a standard. In other words, while machines may be able to read other formats, they should at least be able to read the standard format.

Microsoft has announced that this fall it will introduce Version 2.0 of MS-DOS; among the new features are a visual shell, more user friendliness, network interface (so the system can be used as a work station in a local network), improved utilities (print spooler, debug, etc.) and standard terminal interface including graphics using ANSI (American National Standards Institute) standard escape sequences. Microsoft has disclosed that it is working on MS-DOS enhancements (version 3?) that will include MS-DOS recoded in the C language for easy conversion to other microprocessors, a C compiler to be included with MS-DOS, file I/O transparency across networks, and diskless work stations. Microsoft has also revealed that it is working on language enhancements that will include support for the Intel 8087 floating-point math processor.

As an aside, Microsoft, a privately held company, disclosed that last year it grossed $16 million and this year it expects to double that figure.

More 32-Bit Micros: Bell Laboratories and Hewlett-Packard have disclosed that they will shortly begin manufacturing 32-bit microprocessor integrated circuits. The Bell Labs version is called Bellmac-32A. It is a full 32-bit microprocessor; the data and address buses, internal and external, have 32 lines. All of the registers are 32 bits wide and all instructions operate directly on 32-bit data words. The device, which has close to 150,000 transistors, can directly address a gigabyte of memory. It has been designed with the Unix operating system and the C language in mind.

The HP 32-bit device is a set of ICs that will be used in a new product to be introduced in about a year. The set includes the processor, memory controller, read/write and read-only memory, I/O processor, and clock generator. The processor is on a ¼-inch-square chip that has three to eight times the circuit density of any current IC, according to HP, and contains 450,000 transistors.

Motorola Adds to 68000 family: Motorola has reached an agreement with six other semiconductor manufacturers whereby the companies involved will design new devices to add to the MC68000 family of microcomputers. The joint contributions of Motorola and the six members of the design group (Mostek, Signetics, Rockwell, Hitachi, Thompson CSF, and Philips) allow the addition of far more products to the 68000 product line than any company could do by itself. The new products announced are 8-bit-bus and 32-bit-bus versions of the 68000 microprocessor, a virtual-memory version of the 68000, and a floating-point mathematics processor. Some of the products will not be available until late 1983 or early 1984. The following is a brief look at the announced products.

The 68008 is a 48-pin version of the 68000 that has data and address buses compatible with conventional 8-bit microcomputers. Motorola obviously hopes it will find a market analogous to that of Intel's 8088, an 8-bit-bus variation of the 8086 microprocessor. The 68008 will address one megabyte of memory. Samples will be available in the fourth quarter of 1982.

The 68020 is reported to be the beginning of a 32-bit family of microprocessors. It will have 32-bit-wide data and address paths and will come in several configurations, the largest of which will be a package with 100 pins. Because of mechanical problems with a device of this size, Motorola is discarding the dual-inline design of present ICs for a new package. The address space of this largest configuration will be 4 *billion* bytes of memory. The 68020 will have several interesting features, including a cache memory, a 16-MHz clock (allowing it to execute 1.5 million instructions per second), and an interface to auxiliary coprocessors. One interesting technical note: the chip, which is primarily conventional NMOS (negative-channel metal-oxide semiconductor), will have a small portion of grafted-on CMOS (complementary metal-oxide semiconductor) circuitry. According to Motorola, this will significantly reduce power consumption. Motorola is calling this new process HCMOS III or "merged MOS." Samples are promised for the fourth quarter of 1983.

The 68881 is a floating-point math coprocessor that is said to be the first of a line of coprocessors for use with the 68020 microprocessor and other members of the 68000 family. The unit will handle several degrees of precision, conform to the IEEE (Institute of Electrical and Electronics Engineers) floating-point standard, coprocess with the 68020 whenever possible, and do over 150,000 operations per second. It will also use the HCMOS III technology described above, and samples will be available by the fourth quarter of 1983. The 68452, a bus-arbitration module, and the 68440 dual DMA (direct memory access) coprocessor will be introduced in late 1983 or early 1984.

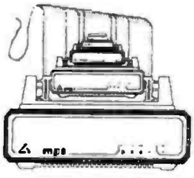
The 68010 is a microprocessor, pin-compatible with the 68000, that will work with the existing 68451 Memory Management Unit (MMU) to create a microcomputer that implements virtual memory (i.e., the majority of the memory will actually reside on a disk and will be swapped in and out of random-access memory automatically). . . . **G. W.**

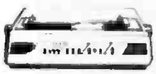
Spreadsheets Proliferate: Visicalc, introduced in late 1979, was the first spreadsheet program. Now about 24 such programs are on the market. Visicalc, without doubt, is the most successful, and to a great extent it has made the Apple II the success that it is.

But Visicalc has some limitations: restricted memory capacity; crude editing, text processing, and formatting; and lack of conditional statements. However, the most serious shortcoming has been the lack of a CP/M version.

Competing spreadsheet programs have capitalized on these limitations. Most run under CP/M. Some offer modeling-language extensions to allow manipulation of the work sheet itself (e.g., Microplan, Plannercalc). Some allow different spreadsheets to associate with one another by means of a sheet-linkage feature (e.g., Multiplan, Calcstar, Forecaster). One (NEC Report Manager) even allows a three-dimensional sheet. Many allow their spreadsheets to share data with other programs.

It is also interesting to note that some software suppliers now offer versions for minicomputers. One supplier (Digicalc) offers a spreadsheet



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program for DEC VAX machines at *only $6,000.*

Color-Graphics Costs Drop: Color-graphics-display terminals are being introduced at new low prices, some under $1000. This is expected to bring color graphics into the business marketplace. In fact, in a few more years, color may become standard. Leading the way now is Intelligent Systems Corporation (ISC), Norcross, Georgia, which is shipping a color-video terminal priced at $995 for single units. Televideo and Applied Digital Data Systems Inc. are expected to introduce competing units by year-end. The ISC unit can display eight foreground and eight background colors on a 13-inch video screen. It includes function keys and firmware for drawing vectors, bar graphs, and point plots. (Incidentally, Megatek Corporation, San Diego, California, has announced a three-dimensional color-graphics terminal: prices start at $50,000.)

Color-printer prices are dropping quickly too. Integral Data Systems has a color impact printer for under $2000 that produces eight colors using a four-band ribbon. Integrex Ltd., England, has developed a color printer based on the Epson MX-80 that it sells for $1995.

A host of companies are producing color pen plotters. The lowest in cost is currently the Radio Shack 6-pen plotter at $1995.

The Japanese have not yet entered this market, although they are known to be developing color printers. When they do enter, substantial price reductions can be expected.

Floppy-Disk News: Last year 568,000 double-sided 5¼-inch disk drives were made. This year the figure should double to 1.1 million drives. Also, track densities are increasing. The 96-tpi (track per inch) density will soon dominate the market. The result is that companies such as Micropolis have announced 5¼-inch drives with 2-megabyte storage capacities. Delivery of these drives has been slowed pending the availability of improved disks. Better materials are necessary because uneven disk coating and thermal and hygroscopic distortion of the disk surface increase errors.

Several companies have announced they will soon start production of 1.6-inch-high 5¼-inch drives. Thus two drives will fit into the space previously occupied by one drive. Half-high 8-inch drives are already available.

Sony's 3½-inch disk drive is being used in Sony's word-processing system. However, because it is available from only a single source, other manufacturers have been leery of designing it into their products. Sony has announced that it will soon introduce a dual-sided version of the drive.

Finally, 68000 Software: I receive many letters from readers of this column regarding the availability of 68000-system software and low-cost hardware. The following, I think, answers most of the questions raised.

It should be noted that Intel introduced its 8086 16-bit microprocessor in 1977—almost five years ago. The first systems using the 8086 became available the following year. However, it was not until 1980-81 that the first DOS development software became available. And it is only now, in 1982—five years later—that applications soft-

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ware packages are beginning to appear.

The 68000 was introduced by Motorola in 1980, and the first 68000 system became available last year. The disk operating systems are only now becoming available, and languages should start becoming available early next year. Therefore, I do not expect to see any significant amount of 68000 applications software becoming available until 1984.

I doubt that the 68000 will have much of an impact on the single-user/single-task personal computer market. Its great strengths will be in the multi-user/multi-tasking market competing against traditional minicomputers. Keep in mind that Microsoft's 68000 DOS (Xenix) requires 50K bytes of 16-bit-wide user memory, as compared to 8086 DOS (MS-DOS), a single-user/single-tasking DOS that occupies only about 5K bytes of memory. I am not currently aware of any companies developing low-cost 68000-based personal computer systems. I would appreciate hearing from anyone who knows of one.

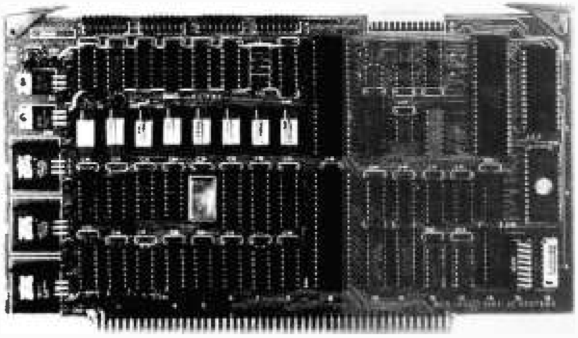
Large Direct-view LCD: Kylex Inc. of Mountain View, California, a subsidiary of 3M Company, has developed a new type of alphanumeric liquid-crystal display (LCD) called the TAD (thermally addressed dye) display that has been incorporated into what is possibly the largest direct-view panel LCD ever made: a 6- by 7-inch, 288- by 357-pixel flat display screen. Each pixel is 15 hundredths of an inch square, and in alphanumeric use 24 lines of 50 characters each can be displayed. The TAD display could make possible a new generation of portable computer terminals.

The TAD technology uses a so-called guest molecule of dichroic dye attached to host molecules of liquid crystal; the two types of molecules have a similar physical structure. In the normal nematic molecular orientation, the dye is invisible. When the liquid-crystal molecules are reoriented in the display, the dye molecules are also reoriented, causing the dye to become visible.

For the liquid-crystal molecules to be changed in orientation, they must first be heated; in the display one row of pixels is heated at a time by an electric heating current passed through heating elements in the panel. The heating places molecules into random orientations, allowing the dye to show up. Then, while all the molecules in the row are cooling down, the pixels that are to be restored to the blank state (i.e., dye not visible) are addressed along the appropriate column by pulses of current.

A unique property of the TAD display is the permanence of its images. Because the pixels must be heated for their states to change, they do not revert to blankness when not in use. You can unplug a TAD display from its control circuitry and keep it in a drawer for a year—and when you take it out, it will still show the image it contained when it was unplugged.

The TAD display is driven by a control module containing a Z80A microprocessor, 4K bytes of read/write memory, 16K bytes of read-only memory, and various other components; the control



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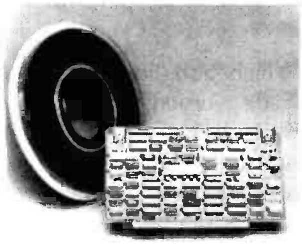

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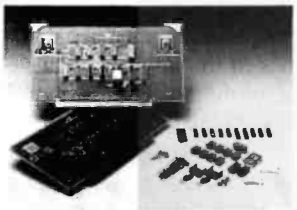

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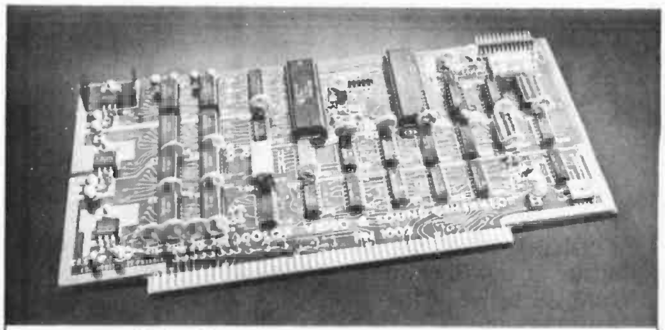

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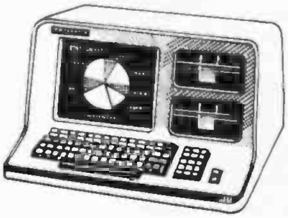

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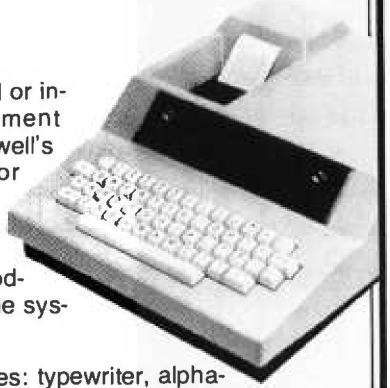

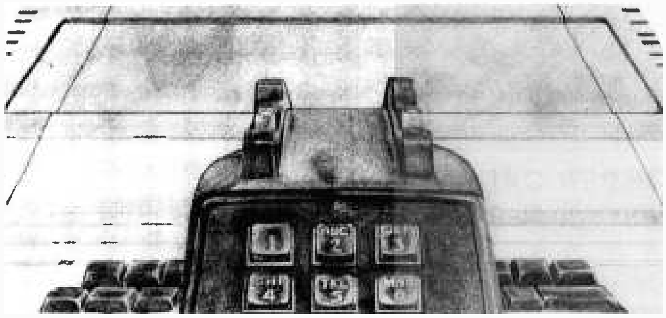

module keeps track of the temperature of the pixel rows to keep the display operating within the most efficient range while using a minimal amount of energy.

The inventor of the TAD technology, Dr. Sun Lu, described his research in a paper delivered in May at a conference of the Society for Information Display. . . . **R. S. S.**

Video Games Battle In Court: Pac-man has replaced Space Invaders in computer-game popularity. In fact, Pac-man has generated nearly $1 billion in arcade sales. Atari is now selling Pac-man cartridges for its home units and expects sales to top that of the arcade version. Warner Communications, Atari's parent company, expects that Pac-man will gross more money than its *Star Wars* film. But there are problems. Magnavox is marketing a game called K.C. Munchkin that Atari claims is "a knock-off of Pac-man." Atari took Magnavox to court and succeeded in enjoining the latter from marketing the game on the basis of copyright infringement; however, a second ruling stayed the first ruling until a full trial could be held.

Pac-man was licensed from Namco of Japan by Bally Manufacturing Corporation, which also licensed the arcade version of Space Invaders (Atari sells the home cartridge version). Bally is now shipping *Ms. Pac-man* games to arcades, and this is expected in cartridge version also.

Apology Due: In my February 1982 BYTELINES column I reported on Condesin, a small research and development company using a new technology to develop a 4-megabit nonvolatile memory. I reported the company as being in Cupertino, California. I have been informed that the company has moved to Texas. As yet I have not been able to locate its new address.

Quote of the Month: "There are eight different ways to insert a disk into a drive. . . only one of which is interesting."
Eddie Currie, Vice President
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MAIL: I receive a large number of letters each month as a result of this column. If you write to me and wish a response, please include a self-addressed, stamped envelope.

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BYTE's Bits

Graphics Printing System

If you are interested in the Graphics Printing System mentioned in the January and February 1982 BYTEs (see pages 443 and 222, respectively), please note that Progressive Software has gone into bankruptcy and will no longer sell or support the program. However, Crow Ridge Associates is selling and supporting the program. It should be noted that the system must be used with the Apple serial interface card with the P8A PROM (programmable read-only memory). It costs $109.95. Contact Crow Ridge Associates Inc., POB 90, New Scotland, NY 12127, (518) 765-3620. ■

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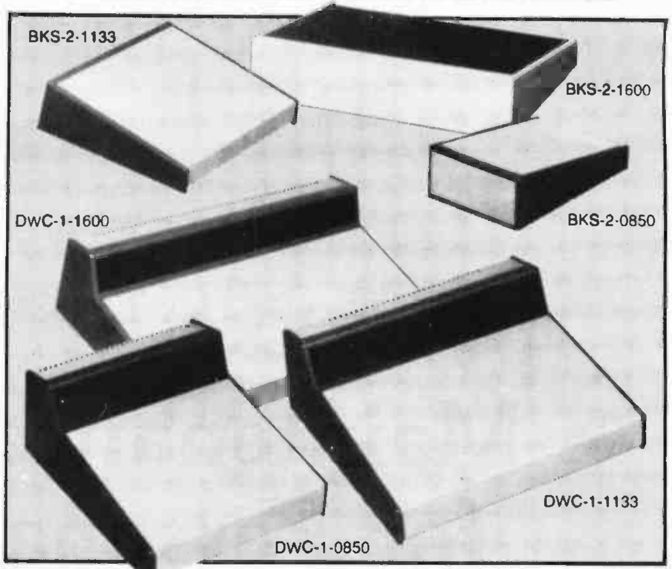

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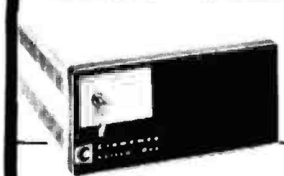

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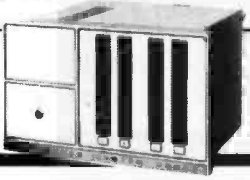

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Maintenance Alternatives for Personal Computers

Repair service options to consider before you buy a computer and preventive maintenance steps to perform once you've made the purchase.

Lewis A. Whitaker
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Whether you have already chosen your personal computer or are in the process of making that important decision, there is something you must consider that is as important as bits, bytes, bauds, and software—maintenance. Suppose you sat down to work at your system and found that the video terminal wouldn't light, the printer wouldn't print, or the computer just wouldn't compute. Where would you turn for help? Ideally you should determine the options for repairing your system before buying it. However, even if you have purchased a computer already, you do have options for obtaining service.

You can take steps to maintain the components of your computer before a failure occurs.

A recent incident taught me the importance of planning maintenance alternatives before disaster strikes. A friend, who had purchased a personal computer through a mail-order catalog, saw his printer stop in the midst of printing a long document. He called me frantically to ask where he could go to have someone fix his machine quickly. Not having an immediate answer, I looked in the Yellow Pages under "computer maintenance." That heading referred me to "computer store," where I found listings for twelve businesses. At this point, I decided that it might be interesting to call each company myself. I called them and the results were surprising, to say the least. Three were no longer in business, four specialized in computer games and video equipment, four were more interested in selling new computers and didn't service my friend's type of equipment anyway, and only one store said it would take a look at the machine if I brought it in. I wondered whether the results of my little survey were typical. If it proved difficult to get quick and efficient service in computer-conscious West Los Angeles, what could the personal computer user in more remote areas expect?

It was not many years ago that all data-processing or scientific computer installations had on-site field

About the Author

Lew Whitaker has spent 20 years in sales and marketing, primarily with companies in the magnetic media field. He was the Western Regional Manager for the Computron (BASF) magnetic tape company and has worked for Data Devices, KYBE Corporation, and Innovative Computer Products. He has had a number of articles published in the Journal of Data Management, Interface Age, *and* Digital Design.

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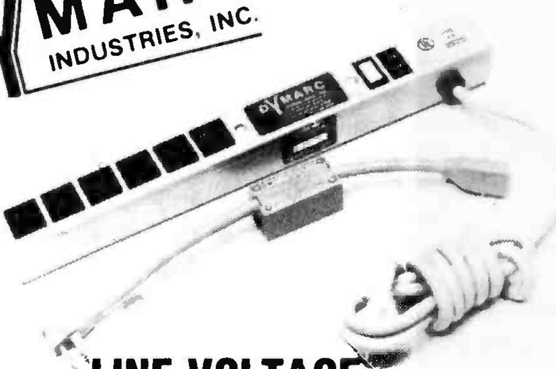

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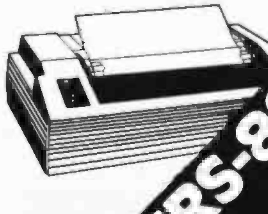

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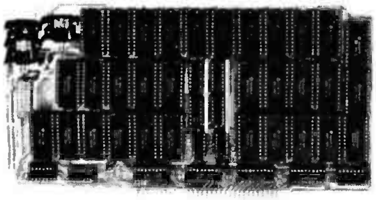

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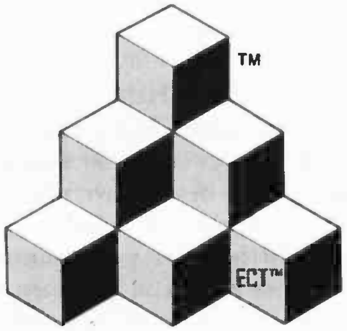

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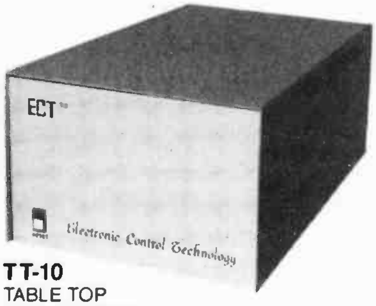

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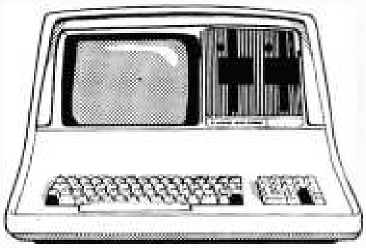

engineers with proper training and enough spare parts to solve whatever problem might arise within a system. Service contracts for computer systems were mandatory and were written as part of the system purchase or lease. The development of solid-state chips has not only accelerated the trend toward smaller and less expensive computer systems but has also greatly improved reliability. There is still a huge segment of the market that addresses large-scale computer systems, which require on-site or on-call field engineers. As the computer system shrinks in size and cost and as the reliability of all components increases, however, there is a need for practical alternatives for computer maintenance. It does not make sense for the Apple or PET user to retain a full-time field engineer. But where should the user go if he wanted to obtain the services of a qualified engineer to perform on-site maintenance? Are there local places where he can bring his machine for service? Must he send his machine back to the factory for even the simplest repairs? Is there anything that the average nontechnical person can do at home to keep costs down and efficiency up? What are the alternatives from which a personal computer user can choose before the first component failure ruins his love affair with his computer?

Where to Go for Help

Computer stores: Many computers are sold through computer stores. In addition to the best-known manufacturers, a number of smaller companies sell their computers through these same stores. The questions that the buyer should ask the seller are the same as if the product under consideration were an automobile or a kitchen appliance: Does the seller offer a maintenance contract? What is the length of the warranty? What does the warranty include? Is the repair site local or are repairs made at a distant facility? Does the seller do the work or does he farm it out to a third party? Does the service provider offer loaner units?

Investigation has shown that there is no such thing as an industry-wide, standard service policy for small computers. My initial disappointing experience in searching for a service company prompted me to make a wider investigation throughout the Los Angeles area. I found that most computer stores offered maintenance of the computers that they sold, but most were also reluctant to discuss turnaround time for repairs. Often they were not even able or willing to quote their hourly service rates. Radio Shack was the only store that had a printed parts and labor price sheet available to the customer. Certain manufacturers, such as Radio Shack and Apple, offer extensions of their warranty, which guarantee that a user can bring his system in for repair anytime during the covered period. However, while Radio Shack service policies are uniform from store to store, the same cannot be said for Apple service policies. I discussed service of Apple computers with several retail outlets. While some were vague at best about turnaround and uncertain about hourly rates, other Apple retail outlets welcomed inquiries into their service policies, offered quick turnaround for most problems, and not only stated rates for service but estimated the time each type of problem would require.

The price of an annual service contract varies from company to company, but it appears that about $2000 is average for an extended warranty contract for a complete personal computer system. Whether you wish to spend the money to purchase a maintenance contract is obviously a personal decision. It is an expensive undertaking to be sure, but a computer sitting idle is both expensive and sad.

Manufacturers: I asked three manufacturers about their factory-direct service policies. Digital Microsystems, Vector Graphic, and Intertec all had similar policies. They preferred the user to go to a local service outlet, but each offered to service the unit at the factory if the customer wished, whether the unit was under warranty or not. The objections to having a machine returned to the factory are simple: time and trouble. Seldom does anyone have the time to

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pack a bulky machine and ship it back to a factory. No one I know keeps the original cartons long, and that helps make long distance shipping complicated. In addition, few owners can afford to be without their machines for the time required. For practical reasons, therefore, factory maintenance should be considered a last resort. But it is comforting to know that a last resort is there if you should ever need it.

Third Party Maintenance: In addition to computer manufacturers and the retail outlets that promise to service what they sell, there is a network of independent service organizations. These companies, such as TRW, Dow Jones, and Sorbus, will write a contract on peripherals. Service organizations work under license to manufacturers and are often the only authorized repair service for a product. Large, nationwide organizations do have their advantages. You can move from Los Angeles to New York and still be assured of finding maintenance. They also perform service on site. The disadvantage of contracting with this type of organization is that you pay for the overhead; rates are high.

A different type of service organization is now emerging: the small, local service company willing to service more than one type of machine, either on site or on a carry-in basis. These companies will offer both an extended warranty contract or a one-time charge for time and materials. Rates quoted for this type of service were $35 to $60 per hour, with a two-hour minimum for on-site service. Remember, however, that there is more to service than cheap rates. The least expensive service contract may not prove least expensive in the long run.

How to Help Yourself

As stated above, early selection of a reliable repair service is strongly recommended. However, you can take steps to maintain the components of your computer before a failure occurs. The following are some simple and effective steps that a personal computer owner can take to care for his or her equipment.

Central processor: This is the "brain" of the computer and fortunately one of its most reliable parts. Because the average personal computer system draws power in the range of 3 to 5 amps, you should not overload the same circuit with other appliances. Overloading a circuit could result in power surges that could blow a fuse or cause unpredictable problems. A typical indication that a fuse has blown is that absolutely nothing happens when the power switch is turned on. If a fuse does blow, replace it with the size recommended by the manufacturer. If the fuse continues to blow, you must call the previously selected service company. Another problem that can affect the operation of the central processor is static electricity. Static electricity, that annoying and shocking "zzzap" so common indoors in winter, can cause data loss or even component failure. An antistatic mat or an antistatic spray is an excellent investment to prevent such failures.

Floppy-disk drive: This peripheral device is the one most likely to fail outright or marginally, causing disruption of processing or actual loss of data. Fortunately, the disk drive is also the peripheral that can benefit most from careful maintenance. Often, the problem is with the floppy disk itself. You should use only top-quality, fully tested, "certified" disks. However, even use of the best disks cannot guarantee that problems will not occur. Magnetic disks require careful handling. The slightest bit of dust or oil between the recording head and the disk surface can cause improper contact. This can prevent data from being written on the disk and can interfere with reading data too. The following rules for floppy-disk care are industry standard. You would be wise to follow them carefully.

1. Do not put fingers, pencils, or other objects through the head-access slot in the vinyl jacket.
2. Keep disks away from large motors or other magnetic fields.
3. Do not bend, fold, or wrinkle the disk's vinyl jacket.
4. Do not write on the vinyl jacket.

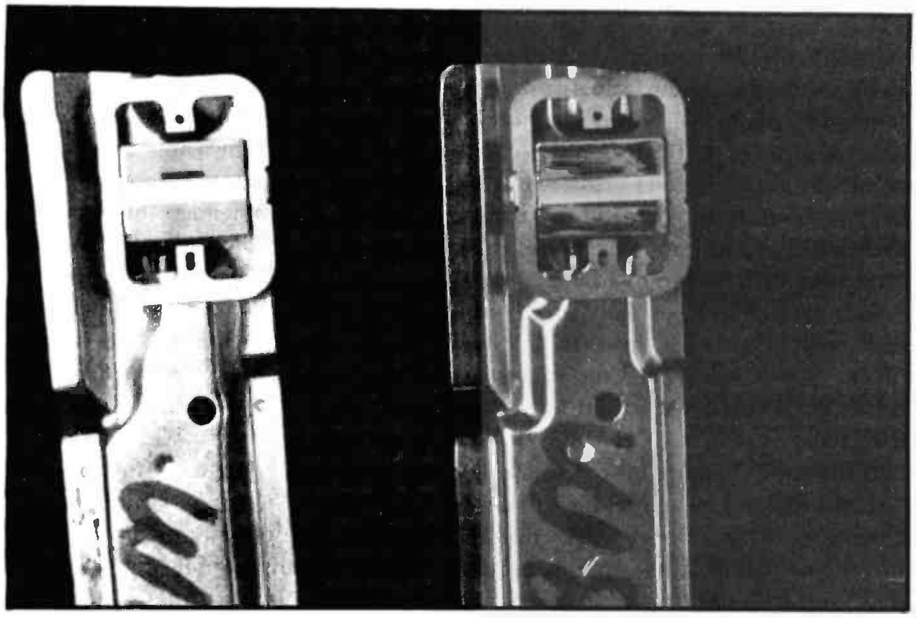

Photo 1: *Contaminants on the read/write head of a floppy-disk drive.*

5. Write on a label *before* affixing it to the jacket.
6. Keep the disk in its envelope when the disk is not in use.
7. Keep the disk and envelope in a protected storage area.
8. Keep disks in an area with a temperature range of 50° to 110°F.
9. Avoid blowing cigarette smoke on the disks.

Caring for the disks is only part of the problem. Equally important is proper care of the recording head. During operation, the read/write head rides on the surface of the disk. When a ceramic head is in constant contact with a rapidly rotating magnetic disk, there is the continual potential for head contamination. Contamination, in the sense used here, means that oxide from the disk is loosened in minute particles and smears onto the surface of the recording head. With oxide particles covering the recording surface of the head (see photo 1) magnetic signals can neither be recorded nor read. Until quite recently, the only way to rid a disk head of contamination was to have a qualified engineer dismantle a drive and manually clean the head surface by gently and carefully scrubbing it with a cotton swab soaked in alcohol. This procedure was both time consuming and potentially dangerous to the drives. A number of head cleaning devices are now available to the user who wants to do the cleaning himself. (For a list of manufacturers, see table 1.) These head cleaning kits, which are available for both 8- and 5¼-inch drives, are of three types:

- Dry cleaners consist of a package of one, two, or three disks per box. The disk is a piece of standard Mylar substrate with a nonabrasive polyester material bonded to it. It is sealed inside a standard vinyl jacket. Examples of this type of cleaner are Compu-Clean and BASF—both European imports.
- Wet/dry cleaners typically consist of two cleaning disks and one bottle of cleaning solution. The cleaning disk is a slightly porous, flexible piece of nonwoven, nonabrasive polyester. It is sealed inside a modified jacket. One side of the jacket has a wide cutout, and the other side, a removable tab. (For single-sided drives, the tab stays in place; for dual-sided, the tab is removed.) The user applies cleaning solution to a third of the disk through the cutout. The disk is placed in the drive as is a normal magnetic disk. The heads are accessed and the disk is left in place for 15 to 20 seconds. While in operation, the disk rotates and cleans by means of a wet/dry, wet/dry action on the heads. Examples of this type of cleaner are 3M and Innovative Computer Products.

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- Wet cleaners use a nonabrasive material totally saturated with an alcohol-based cleaning solvent. A recent entry from Verbatim Corporation uses this concept. It consists of a nonabrasive, polyester disk which has been presaturated with a solution and sealed in a foil pouch. To use, the saturated disk is removed from the pouch, placed in a specially provided disk jacket, and then inserted in the drive. After allowing the disk to rotate under the head for 30 seconds, the jacket is removed from the drive and the used cleaning disk discarded.

Hard-disk drives (cartridge or Winchester): While floppy-disk drives have heads that actually touch the disk surface, hard-disk drives have heads that "fly" on a thin cushion of air—in some cases as thin as 20 microinches. Even more than with a floppy-disk drive, it is important that the surface stay perfectly clean. When a hard disk is rotating at more than 2000 revolutions per minute with a head only 20 microinches above the surface, a bit of dust or contamination can destroy not only the delicate recording head but the surface as well (see figure 1). Cleaning the disk cartridge surface (removable single platter cartridges, not Winchesters) is generally recommended three to four times per year, depending on the operating environment. Firms in major cities across the country perform cleaning and testing services as required. Examples of companies that perform this type of service are Scopus, Randomex, and PMI. If you have a large enough library of disk cartridges to warrant your own in-house cleaning equipment, cleaners or cleaner/inspection devices are available from Burroughs Corporation, NCR, DEC, Randomex, Data Devices, and Innovative Computer Products. Other than performing a periodic disk cleaning and keeping the area where disks are stored and operated free from dust, there is little more a user of hard-disk equipment can do. If a removable disk is at all

THE EFFECT OF DIRT ON A MAGNETIC DISK

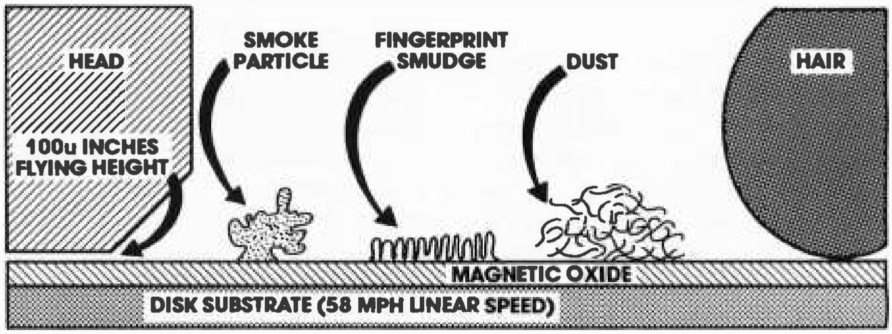

Figure 1: *Hazards for hard disks: the smoke particle, the fingerprint smudge, and dust. Because only a minute cushion of air holds the read/write head above the disk surface, contaminants dwarfed by a human hair pose serious problems.*

Company	Address
Data Recording Products Division	3M Center St. Paul, MN 55144
Computer Resources Corporation	4650 W. 160th St. Cleveland, OH 44135
Verbatim Corporation	323 Soquel Way Sunnyvale, CA 94086
Innovative Computer Products	18360 Oxnard St. Tarzana, CA 91356
BASF Systems Corporation	Crosby Dr Bedford, MA 01730

Table 1: *Some manufacturers of cleaning kits for the read/write heads of floppy-disk drives.*

suspect (e.g., if it has been roughly handled, dropped, or left in an environmentally harsh area), have the disk tested *before* attempting to load it on the system. Replacement of disk-drive heads is costly.

Printers: Because a printer is an electromechanical device, it can often be the source of annoying maintenance problems. The computer printer is much like a typewriter. It functions well until a buildup of paper particles and household dust interferes with operation. The printer then requires an expensive, professional cleaning. Other than having a maintenance contract, all a user can do is keep the print mechanism free from accumulated ink and paper dust. Commercial cleaning kits are available for wiping contamination from the print elements. These kits are sold by companies such as Texwipe, Innovative Computer Products, and a number of nationwide catalog distribution companies such as INMAC and Visible Computer. Clean typing elements will give sharp, clear print. You should have a plastic cover to protect the printer when it is not in use.

Conclusions

Although personal computers today are more compact and much more reliable than computers of 20 years ago, they are still a complex combination of electronic and mechanical components. Preventing problems is the best maintenance most personal computer owners can perform. Cleaning kits are available for disk drives, printers, and video screens. Mats and sprays are available to prevent static electricity. Plastic covers are available to protect computers and peripherals from dust. Keeping your computer free of contamination and trouble is by far the least expensive of the maintenance methods available to personal computer users.

When preventive maintenance is not enough and you need professional help, be sure that you have thoroughly researched the available service options. The decision you make will affect not only your pocketbook but also your mental health. ■

Text-Handling Routines in Extended BASIC

Roger Greenhalgh
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Raleigh, NC 27612

As home computers have grown in popularity, their uses have developed in four general categories: games, problem solving, financial analysis, and word and file processing. Most users eventually want some sort of text-handling capability.

Many good text handlers already exist, but for those who would like to compile their own, I'll describe a group of BASIC subroutines designed to work together (see listing 1). You can use them complete as listed, in part, or as instructions for generating your own.

These subroutines operate by means of an *interactive* method. Text is entered, then commands are entered for actions on the text. Most commands issue prompts that augment the indication of what is wanted. Many commands, for example, prompt for the range of line numbers of the text to be operated upon. (This method contrasts with that of embedding commands into the text as it's entered. The interactive mode was chosen so that fewer symbols and less structure need to be remembered.)

Table 1 lists brief descriptions of each subroutine (a more in-depth description of each follows); BASIC statement numbers are included in parentheses. Inevitably, the specific characteristics of my personal-computer system show through. These are pointed out where deemed significant.

Subroutine Descriptions

LN: line number (170). The system assigns and maintains line numbers sequentially for each line of text. LN holds the number for the next line to be entered. The LN command lets you set LN to any number. Existing text at LN and higher numbers will be overwritten as additional text is entered. (In my system, the date is extracted from the operating system and placed in line 1.)

LL: line length (210). LL determines the line length desired for text justification. It's initialized at 65 but can be changed at any time. Of course, input text can exceed this number. It's used only for text justification.

N: next text entry (230, 500 through 580). In response to N, the symbol * (asterisk) is displayed at position LL to visually indicate the line length. Then the prompt GOTO is issued. If your response is 0, the line of text entered will be placed at LN. All text lines entered subsequently will be placed at LN+1, LN+2, etc. When the text entered for a line is the word *exit*, the system reverts to the command prompt. If your response to GOTO is a specific line number, the text entered will be put into that line, replacing any existing text. The system then reverts to the command prompt.

SH: shift text (180, 700 through 770). SH results in the prompt FROM, TO, INTO. All lines of text indicated by the range FROM, TO are shifted into a new area, beginning with line number INTO. Shifting can take place both up and down the page without concern about overwriting. Text is erased from the old area. For example, if lines FROM 5, TO 10 are shifted INTO 4, then line 5 goes into line 4, line 6 into line 5, etc. If they are shifted INTO 12, then line 10 goes into line 17, line 9 into line 16, etc. Shifting is invoked by the system when justification causes paragraph overflow.

The instructions at line 700 determine the direction of shifting. Lines 710 through 740 cause shifting down the page. Line 730 adjusts the value of LN to indicate the new line number for the bottom of the page. Lines 750 through 770 cause shifting up the page. Here the value of LN is not

Command	Action	Prompt
LN	line number	SET LN =
LL	line length (initialized at 65)	LL = XX SET LL =
N	next text entry	GOTO XX SPECIFIC LINE. 0 FOR NEXT LINE AFTER TEXT AND CONTINUE. 'EXIT' TO COMMAND.
SH	shift text	FROM, TO, INTO.
CO	copy text	FROM, TO, INTO.
T	tab setup	TABS T1 T2 T3 ?
TP	table position setup	P1,P2,P3,P4,P5 ?
E	ends	

All following request range of lines FROM, TO.

Command	Action	Prompt
D	display text	
TAB	tab text	
J	justify text	
COL	columnize data	
P	print text	
C	center text	
I	indent text	INDENT X SPACES.
F	find	'FIND' WORD CONVERT TO UPPER? Y-YES. WHICH LINE? OF HOW MANY LINES?
R	replace	'FIND' WORD CONVERT TO UPPER? Y-YES. REPLACE WITH CONVERT TO UPPER? Y-YES.
SO	sort records	WHICH LINE?, OF HOW MANY LINES?, SORT WORD FROM LEFT?
CA	caption text	'PRINTS LINE WITH LINE NUMBER' CAPTION? CONVERT TO UPPER? Y-YES.
U	uppercase conversion	
S	save file	ENTER FILE NAME.
G	get file	ENTER FILE NAME. 0, ANY-PLACE AT LINES SPECIFIED IN SAVE. N, ANY-PLACE AT LINES STARTING WITH N.

Notes: [yields uppercase for next letter. Tab or columnize to next position. On 'CRASH' GOTO 150, continue. The date is loaded into line 1.

Table 1: *A simple, quick-reference chart showing capabilities of the text-handling routines.*

altered because the area shifted may not be from the bottom of the page.

CO: copy text (190, 1400). All text in the range indicated in response to the prompt FROM, TO is copied into the area starting with the line number INTO. Text is not erased from the old area. Copying allows various text-editing experiments without losing the original input. Protection against overwriting on down-page copying is not provided.

T: tab setup (220). Three tab positions are provided in this routine. The prompt TABS displays existing values. Three inputs are required in response to the prompt. Tabs not needed can be set far to the right. If more tabs are needed, they can be entered for a second pass through the text.

TP: table position setup (240 through 270). When printing tabular data, it's desirable to line up the units positions of all entries in a column. This routine defines units positions for five columns. The prompt displays the present values and requires five inputs; those not needed can be set far to the right.

Note: all the following commands prompt by line numbers for the range of the text to be operated on; the prompt is FROM, TO. If the response is entered as 0,0, all lines from 1 to LN are used. If XX,0 or XX,XX is entered, only the single line XX is used. If XX,YY is entered, lines XX to YY are used.

E: end (200). Simply stops program execution and exits to the immediate mode of the BASIC interpreter.

D: display text (320, 600). All lines in the range are displayed with line numbers.

TAB: tab text (330, 800 through 820, 1800 through 1930). This routine causes text to be tabbed out to the positions indicated by TP. The routine searches lines in the range specified for the embedded symbol] (right bracket). When the right bracket is found, enough spaces are inserted into the text so that the next character after] will be placed in the column indicated by the next higher TP position.

Line 800 tests to determine whether or not any of the TP positions is other than zero. Line 1820 searches for the position of any], and line 1830 ends the processing of that line if none is found. Lines 1840 through 1860 determine the column of the next-higher TP position. Lines 1900 through 1910 generate the proper number of spaces, and line 1920 *inserts them* into the string.

J: justify text (340, 900 through 1100, 1600 through 1790). The justification routine handles in turn each line of text in the range specified. If a line is too long (i.e., exceeds LL), words are stripped off the right end. These overflow words are added to the beginning of the next line.

For a line shorter than LL, spaces are added to fill the line out to LL.

Listing 1: *Text-handling routines. This program is written in Extended BASIC. The routines may be used as they appear by simply running the program or they may be incorporated into user programs as necessary.*

```
00100 DIM I$(255):N=1:DIM P(5)
00110 FOR A=1 TO 9
00120 I$(1)=I$(1)+CHR$(PEEK(8332+A))
00130 NEXT A
00140 L=65
00150 C$="":C1=0:C2=0:C3=0
00160 LINE INPUT "COMMAND ";C$
00170 IF C$="LN" THEN PRINT "N=";N+1:INPUT "SET LN= ";N:N=N-1:GOTO 150
00180 IF C$="SH" THEN INPUT "FROM,TO,INTO ";A1,A2,C3:GOSUB 700:GOTO 150
00190 IF C$="CO" THEN INPUT "FROM,TO,INTO ";A1,A2,C3:GOTO 1400
00200 IF C$="E" THEN END
00210 IF C$="LL" THEN PRINT "LL=";L:INPUT "SET LL= ";L:GOTO 150
00220 IF C$="T" THEN PRINT "TABS ";T1,T2,T3:INPUT T1,T2,T3:GOTO 150
00230 IF C$="N" THEN PRINT TAB(L)"*":GOTO 500
00240 IF C$<>"TP" GOTO 280
00250 PRINT "TABLE POSITIONS ";P(5);" ";P(4);" ";P(3);" ";P(2);" ";P(1)
00260 INPUT P(5),P(4),P(3),P(2),P(1)
00270 GOTO 150
00280 INPUT "FROM,TO ";C1,C2
00290 IF C1=0 THEN A1=1:A2=N:GOTO 320
00300 IF C2=0 THEN A1=C1:A2=C1:GOTO 320
00310 A1=C1:A2=C2
00320 IF C$="D" GOTO 600
00330 IF C$="TAB" GOTO 800
00340 IF C$="J" GOTO 900
00350 IF C$="P" GOTO 1200
00360 IF C$="I" THEN INPUT "INDENT X SPACES ";C3:S$="":GOTO 1300
00370 IF C$="CA" GOTO 2800
00380 IF C$="U" GOTO 2900
00390 IF C$="COL" GOTO 2000
00400 IF C$="F" GOTO 2500
00410 IF C$="C" GOTO 1500
00420 IF C$="R" GOTO 2600
00430 IF C$="S" GOTO 3200
00440 IF C$="G" GOTO 3300
00450 IF C$="SO" GOTO 2200
00460 GOTO 150
00500 INPUT "GOTO ";C1
00510 IF C1<>0 GOTO 570
00520 PRINT "INPUT"
00530 N=N+1
00540 LINE INPUT ;I$(N)
00550 IF I$(N)="EXIT" THEN I$(N)="" :N=N-1:GOTO 150
00560 GOTO 530
00570 LINE INPUT "INPUT";I$(C1)
00580 GOTO 150
00600 FOR A=A1 TO A2:PRINT A;" ";I$(A):NEXT A:GOTO 150
00700 IF C3<A1 GOTO 750
00710 FOR A=A1 TO A2
00720 I$(C3+A2-A)=I$(A2+A1-A):I$(A2+A1-A)=""
00730 NEXT A:IF N<C3+A2-A1 THEN N=C3+A2-A1
00740 RETURN
00750 FOR A=A1 TO A2
00760 I$(C3+A-A1)=I$(A):I$(A)=""
00770 NEXT A:RETURN
00800 IF T1 AND T2 AND T3=0 THEN GOTO 150
00810 FOR F=A1 TO A2:S$=I$(F):GOSUB 1800
00820 I$(F)=S$:PRINT F;" ";I$(F):NEXT F:GOTO 150
00900 S3$="":S5=0
00910 FOR F=A1 TO A2
00920 S2$=LEFT$(I$(F+1),1):S5=0
00930 IF S2$=" " OR S2$="" THEN S5=1
00940 S$=I$(F):GOSUB 1600:I$(F)=S$
00950 PRINT F;" ";I$(F)
00960 IF S5=1 AND S3$<>"" GOTO 1040
00970 NEXT F
00980 A4=A2:N1=N:S5=1
00990 IF S3$="" GOTO 150
01000 A4=A4+1:N1=N1+1
01010 A1=A4:C3=A4+1:A2=N1-1
01020 GOSUB 700:S$="":GOSUB 1600:I$(A4)=S$
01030 PRINT A4;" ";I$(A4):GOTO 990
01040 N1=N:S5=1:A4=F:A5=A2
01050 IF S3$="" THEN A1=F+1:A2=A5:GOTO 900
01060 A4=A4+1:N1=N1+1
01070 A1=A4:C3=A4+1:A2=N1-1
01080 GOSUB 700:A5=A5+1
01090 S$="":GOSUB 1600:I$(A4)=S$
```

Listing 1 continued on page 464

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System Notes

Listing 1 continued:

```
01100 GOTO 1050
01200 OPEN "AT:" FOR WRITE AS FILE #1
01210 FOR A=A1 TO A2:PRINT #1,I$(A):NEXT A
01220 CLOSE #1:GOTO 150
01300 FOR A=1 TO C3:S$=S$+" ":NEXT A
01310 FOR A=A1 TO A2:I$(A)=S$+I$(A)
01320 PRINT A;" ";I$(A):NEXT A:GOTO 150
01400 FOR A=A1 TO A2:I$(C3+A-A1)=I$(A):NEXT A:GOTO 150
01500 FOR A=A1 TO A2
01510 B=LEN(I$(A))
01520 D=INT((L-B)/2)
01530 FOR F=1 TO D
01540 I$(A)=" "+I$(A)
01550 NEXT F
01560 NEXT A
01570 GOTO 600
01600 S$=S3$+S$:S3$="":S1$=" "
01610 B=LEN(S$)
01620 IF B<L-10 OR B=L THEN RETURN
01630 IF B>L GOTO 1730
01640 C=L-B:P=1
01650 IF C=0 THEN RETURN
01660 A=MATCH(S$,S1$,P)
01670 IF A=P THEN P=P+1:GOTO 1660
01680 IF A=B OR A=0 THEN P=1:S1$=S1$+" ":GOTO 1660
01690 IF A<L-20 AND RND(1)>.7 THEN P=A+1:GOTO 1660
01700 S2$=LEFT$(S$,A)+" "+RIGHT$(S$,B-A)
01710 C=C-1:P=A+2:B=B+1:S$=S2$
01720 GOTO 1650
01730 A=1
01740 S1$=MID$(S$,L+2-A,1)
01750 IF S1$<>" " THEN A=A+1:GOTO 1740
01760 S3$=RIGHT$(S$,B-L-2+A)
01770 IF S5=0 THEN S3$=S3$+" "
01780 S$=LEFT$(S$,L+1-A)
01790 GOTO 1610
01800 T5=0
01810 S2$="":T4=LEN(S$)
01820 A=MATCH(S$,"]",1)
01830 IF A=0 THEN RETURN
01840 IF A<T1 THEN T5=T1:GOTO 1880
01850 IF A<T2 THEN T5=T2:GOTO 1880
01860 IF A<T3 THEN T5=T3:GOTO 1880
01870 GOTO 1920
01880 IF A=T5 GOTO 1920
01900 FOR T6=A TO T5-1
01910 S2$=S2$+" ":NEXT T6
01920 S3$=LEFT$(S$,A-1)+S2$+RIGHT$(S$,T4-A)
01930 S$=S3$:GOTO 1810
02000 FOR A=A1 TO A2
02010 B=1:S2$=""
02020 P=MATCH(I$(A),"]",B)
02030 IF P=0 GOTO 2100
02040 FOR M=1 TO 5
02050 IF P<=T(M) THEN B=T(M):GOTO 2070
02060 NEXT M
02070 FOR G=1 TO T(M)-P+1:S2$=S2$+" ":NEXT G
02080 S1$=LEFT$(I$(A),T(M-1))+S2$+MID$(I$(A),T(M-1)+1,P-T(M-1)-1)+RIGHT$(I$(A),P+1)
02090 I$(A)=S1$:GOTO 2020
02100 PRINT A;" ";I$(A):NEXT A:GOTO 150
02200 INPUT "WHICH LINE?,OF HOW MANY LINES?,SORT WORD FROM LEFT? ";L1,L2,W
02210 FOR A=A1+L1-1 TO A2+L1-1 STEP L2
02220 W1=0:S1=0:C=1:S=0:S1$="":S2$=""
02230 S1$=MID$(I$(A),C,1):C=C+1
02240 IF S1$=" "THEN S1=0:GOTO 2300
02250 IF S1$=" "GOTO 2300
02260 S=1
02270 IF S1=0 THEN W1=W1+1:S1=1
02280 IF W1<>W GOTO 2230
02290 S2$=S2$+S1$:GOTO 2230
02300 IF S=0 GOTO 2230
02310 IF W1<W GOTO 2230
02320 S4$(A)=S2$
02330 NEXT A
02340 A3=A2+L2-1
02350 S=0:A2=A2-L2
02360 FOR J=A1+L1-1 TO A2+L1-1 STEP L2
02370 IF S4$(J)<=S4$(J+L2) GOTO 2450
02380 S1$=S4$(J):S4$(J)=S4$(J+L2)
02390 S4$(J+L2)=S1$
```

Listing 1 continued:

```
02400 FOR A=J-L1+1 TO J-L1+L2
02410 S1$=I$(A):I$(A)=I$(A+L2)
02420 I$(A+L2)=S1$
02430 NEXT A
02440 S=1
02450 NEXT J
02460 IF S=1 GOTO 2350
02470 A2=A3:GOTO 600
02500 LINE INPUT "'FIND' WORD ";F$
02510 LINE INPUT "CONVERT TO UPPER? Y-YES ";U$
02520 IF U$="Y" THEN S$=F$:GOSUB 3000:F$=S$
02530 INPUT "WHICH LINE?,OF HOW MANY LINES? ";L1,L2
02540 FOR A=A1+L1-1 TO A2+L1-1 STEP L2
02550 IF MATCH(I$(A),F$,1)<>0 THEN PRINT A;" ";I$(A)
02560 NEXT A
02570 GOTO 150
02600 LINE INPUT "'FIND' WORD ";W$
02610 LINE INPUT "CONVERT TO UPPER? Y-YES ";U$
02620 IF U$="Y" THEN S$=W$:GOSUB 3000:W$=S$
02630 D=LEN(W$)
02640 LINE INPUT "REPLACE WITH ";X$
02650 LINE INPUT "CONVERT TO UPPER? Y-YES ";U$
02660 IF U$="Y" THEN S$=X$:GOSUB 3000:X$=S$
02670 FOR A=A1 TO A2
02680 E=LEN(I$(A))
02690 J=MATCH(I$(A),W$,1):IF J=0 THEN NEXT A:GOTO 150
02700 S$=LEFT$(I$(A),J-1)+X$+RIGHT$(I$(A),E-J-D+1)
02710 I$(A)=S$:PRINT A;" ";I$(A)
02720 GOTO 2680
02800 T7=0:IF T1 OR T2 OR T3<>0 THEN T7=1
02810 FOR J=A1 TO A2
02820 PRINT J;" ";I$(J):LINE INPUT "CAPTION? ";F$
02830 LINE INPUT "CONVERT TO UPPER? Y-YES ';U$
02840 IF U$="Y" THEN S$=F$:GOSUB 3000:F$=S$
02850 D=LEN(F$):E=LEN(I$(J))
02860 I$(J)=F$+RIGHT$(I$(J),E-D)
02870 PRINT J;" ";I$(J):NEXT J:GOTO 150
02900 FOR F=A1 TO A2:S$=I$(F):GOSUB 3000
02910 I$(F)=S$:PRINT F;" ";I$(F):NEXT F:GOTO 150
03000 A=1:C=LEN(S$)-1
03010 B=MATCH(S$,"[",A)
03020 IF B=0 THEN RETURN
03030 S$=LEFT$(S$,B-1)+CHR$(ASC(MID$(S$,B+1,1))+32)+RIGHT$(S$,C-B)
03040 A=B+1:C=C-1:GOTO 3010
03200 LINE INPUT "ENTER FILE NAME ";C$
03210 OPEN C$ FOR WRITE AS FILE #1
03220 PRINT #1,A1:PRINT #1,A2
03230 FOR A=A1 TO A2:PRINT #1,I$(A):NEXT A
03240 CLOSE #1:GOTO 150
03300 LINE INPUT "ENTER FILE NAME ";C$
03310 OPEN C$ FOR READ AS FILE #1
03320 INPUT #1,A3:INPUT #1,A4
03330 A2=A1+A4-A3
03340 IF A1=0 THEN A1=A3:A2=A4
03350 N=MAX(N,A2)
03360 FOR A=A1 TO A2:LINE INPUT #1,I$(A):NEXT A
03370 CLOSE #1:GOTO 150
```

Spaces are added randomly with an algorithm that favors the left side of the line. If a line is shorter than LL by more than 10 positions, it is assumed to be the last line of a paragraph and is not justified.

A blank line or a space at the beginning of a line is assumed to mark a new paragraph. Beginning spaces are preserved (not added to by the justification). If a line overflow occurs at the end of a paragraph or at the end of the range, the shifting routine is called to shift the following text down page.

Lines 900 through 970 handle each line and test for the end of the paragraph. Lines 980 through 1030 handle range overflow. Lines 1040 through 1100 handle paragraph overflow. Lines 1600 through 1640 add previous overflow to the current line and find line length. Lines 1650 through 1720 insert spaces to pad out the line to LL. Lines 1730 through 1790 strip off line overflow at a word boundary.

COL: **columnize data** (390, 2000 through 2100). The columnize-data routine allows handling of tabular data while maintaining the data's lined-up units positions. The column positions desired for the low-order digits are specified by the user with the TP command. Of course, this routine can be used with text as well as data.

The routine searches each line from left to right, looking for the symbol]. The column containing this symbol is compared with TP columns, and the TP with the next-higher column number is selected. The substring that ends one column to the left of the] is moved to the right so that it will end in the selected TP column. The length of this substring spans from the next-lower TP column plus one to the column holding the symbol], minus one. Spaces are inserted to fill between the substring and the lower TP. The number of spaces equals the column number of the selected TP minus the column number of the symbol], plus one.

No program precautions are made for data that exceed the distance between adjacent TP columns. Where a table entry is to be passed, use successive] symbols.

P: print text (350, 1200 through 1220). This routine prints the text in the range specified on the output printer. Because it is assumed the output represents the final document, line numbers are omitted.

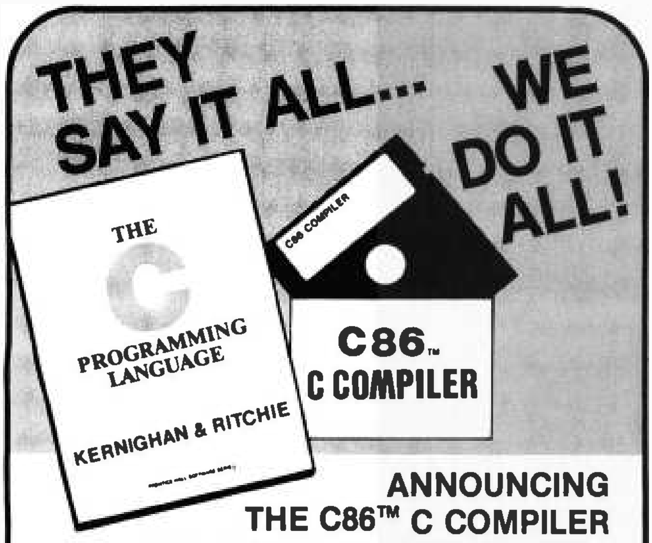
C: center text (410, 1500 through 1570). In some circumstances, it's desirable to center report and paragraph headings. The lines in the range are operated upon, and centering is performed relative to LL. The length of the line is compared with LL, and enough spaces are added to the left to obtain centering.

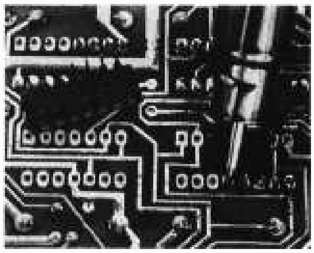
I: indent text (360, 1300 through 1320). All lines in the range are indented the number of spaces indicated by the user. A string of spaces is added to the beginning of each line. This routine can be implemented after text has been entered and justified in preparation for adding a numbering scheme using the caption routine.

F: find (400, 2500 through 2570). Find prompts the user for a *find word* that is used as a search argument. This argument can be a word, phrase, or part of a word. It can be converted to uppercase.

All lines in the range that contain the search argument are displayed with line numbers. If records of more than one line are involved, the search can be limited to a specific line in each record. In such a case, the range is specified as covering the area from the first line in the first record to the first line in the last record. The routine prompts for which line of how many lines. The search is done by detecting the first match, if any, in a line. Lines 2500 through 2530 prompt for the necessary input. Line 2550 determines whether or not a match occurs and, if so, prints the line.

R: replace (420, 2600 through 2720). The replace routine operates in much the same manner as the find routine. A search string and a replace string are entered; either can be con-





verted to uppercase, and the two strings need not be of the same length. Searching is not terminated when the first match is made, allowing multiple matches and replacements in the same line. Since this is the main editing routine and single-line operation is the norm, record-handling capability has not been included.

Lines 2600 through 2660 prompt for the find word and the replace word and call uppercase conversion if indicated. Lines 2670 through 2720 search for a match and, where found, insert the replacement. Line 2690 tests for no match and advances to the next line.

SO: sort records (450, 2200 through 2470). This routine allows sorting of complete records. A restriction: the sort word must be in the same position in all records, determined by counting words from the left of lines. Assume records have the form:

First-name Last-name
Street
City State Zip

To sort on Last-name, in response to the prompt WHICH LINE?, of HOW MANY LINES?, SORT WORD FROM LEFT?, the input would be 1, 3, 2. The range specified covers the area from the first line of the first record to the first line of the last record. To sort one-line records, the input is 1, 1, X.

The routine copies the key sort-word from each record and creates a file of these words. Then a *bubble sort* is used to sort this new file. As each transposition is made in this file during the bubble sort, the lines of the corresponding records are also transposed. Lines 2100 through 2330 copy the key words into the sort file. Line 2210 assures selection of the proper line in each record. Lines 2340 through 2470 contain the bubble sort and handle record transpositions.

CA: caption text (370, 2800 through 2910). The CA command replaces the leftmost characters in a line with a caption string. A different caption can be used with each line in the range specified. The length of the string replaced equals the length of the caption.

This feature has two possible uses. First, text can be justified, then indented. With CA a numbering scheme can be inserted into the left margin. Second, data can be put into columns and item identifiers can later be entered.

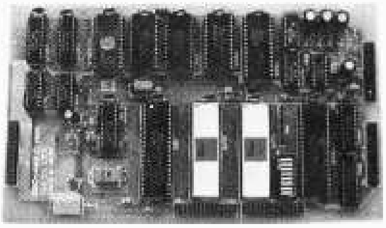
U: uppercase conversion (380, 2900 through 3040). Some systems (at least mine) handle only uppercase in the display, while the printer will handle both uppercase and lowercase. To generate uppercase, the symbol [(left bracket) is used in front of each character to be capitalized. Thus, input text displayed as [text appears on the printer as Text. The subroutine searches each line of text for the symbol [. When one is found, a fixed amount is added to the next character for the code conversion.

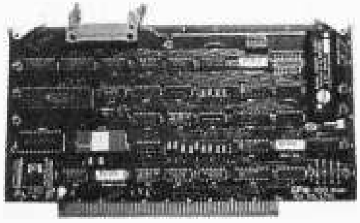
S: save file (430, 3200 through 3240). Save file permits storage of the text in a file. The BASIC commands are specific to my system, which uses a disk. Length of the record is determined by the line numbers entered as FROM, TO. The routine prompts for the file name, which must be used to obtain the file again.

G: get file (440, 3300 through 3370). This is the companion command to Save file. The file with the name specified is returned. The range is used to determine where on the page the file is to be placed. For the range 0,X (where X is any number), the entire file is placed at the same lines used in the SAVE command. If the range is N,X, the entire file is brought in, starting at line number N.

Short and Sweet

These subroutines are intended to help those of you who want to build text handling into your own programs. The program as listed will run on some systems with Extended BASIC and work for manually manipulating text. The interactive scheme is, perhaps, the most important point, as it should help to make your programs user-friendly.■





Omni Aviation Navigation System

Simulate aircraft instrument navigation using simple trigonometry.

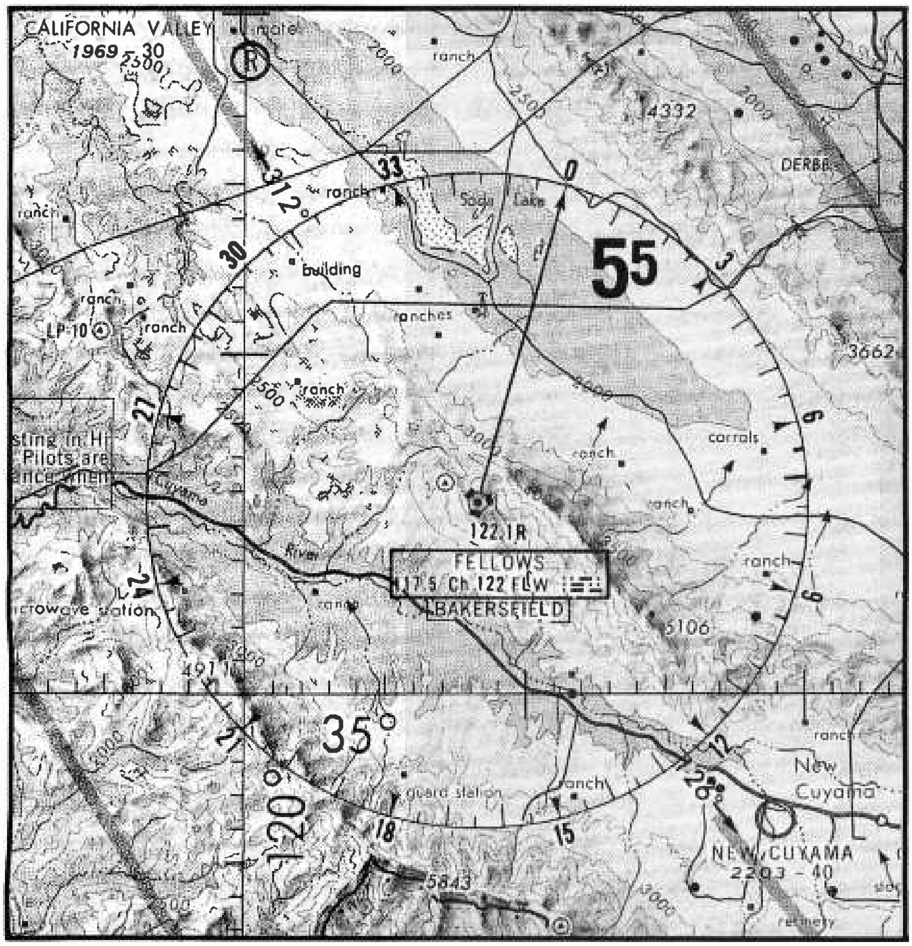


Photo 1: *Typical VOR as represented on an aircraft navigation map. The information block contains the station's frequency and the three-letter code it broadcasts.*

Richard Campbell
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Windsor, CA 95492

Computer simulation is a practical and, in many cases, an economical method for training people to respond to situations they have never actually experienced. Rising fuel costs in recent years have forced airlines to make more frequent use of simulation in pilot training and testing. The cost of training a pilot in an empty Boeing 747, for example, is astronomical. Training by simulation not only cuts that cost, it also allows the pilot to practice emergencies that could pose grave dangers if practiced in a real aircraft. Simulation also is gaining popularity in general aviation, especially for aircraft instrument training.

For beginning pilots, one of the most time-consuming and difficult aspects of flying is navigation using the very high frequency Omni-directional range system, commonly known as VOR or Omni. This article presents a program for simulating Omni on a nonspecialized computer system.

More than 800 Omni stations in the United States make up the Federal Airways Network, with many more stations worldwide. Aircraft navigation charts indicate Omni stations with a compass rose accompanied by a station-identification block (see photo 1). The station-identification block gives the frequency of the station, along with the three-letter identification code the station transmits.

The station also transmits an infinite number of *radials*. But because of the resolution of the aircraft navigation receiver, we can pretend there are only 360 radials—one for each degree of a circle, radiating from the center of the station like spokes from a wheel. The station's 0° radial points to the north, the 90° radial points east, the 180° south, and the 270° west. If you know what radial you are on, you can draw an LOP (line of position) along that radial and through the center of the station on a map. With two Omni stations, you can draw two LOPs. The intersection of these two lines is the position of the aircraft (see figure 1). You can fly *toward* a station by choosing a course that is the reciprocal of the radial you are on or away from the station by making your course match the radial (see figure 2). If this sounds confusing, imagine trying to keep it all straight while learning to fly the airplane at the same time.

The Omni station works by modulating its radio output with two 30-Hz (cycles per second) sine waves. One is called the reference wave, the other the variable wave. The radial of your position is determined by the phase angle between the two waves. At the 0° radial, the waves are in phase; at the 90° radial, they are 90 degrees out of phase; and so on around the circle.

To illustrate this concept, let's build an imaginary station that operates like a real one. Picture the station as a box topped with a wheel that rotates clockwise in a horizontal plane. In the center of the wheel is a

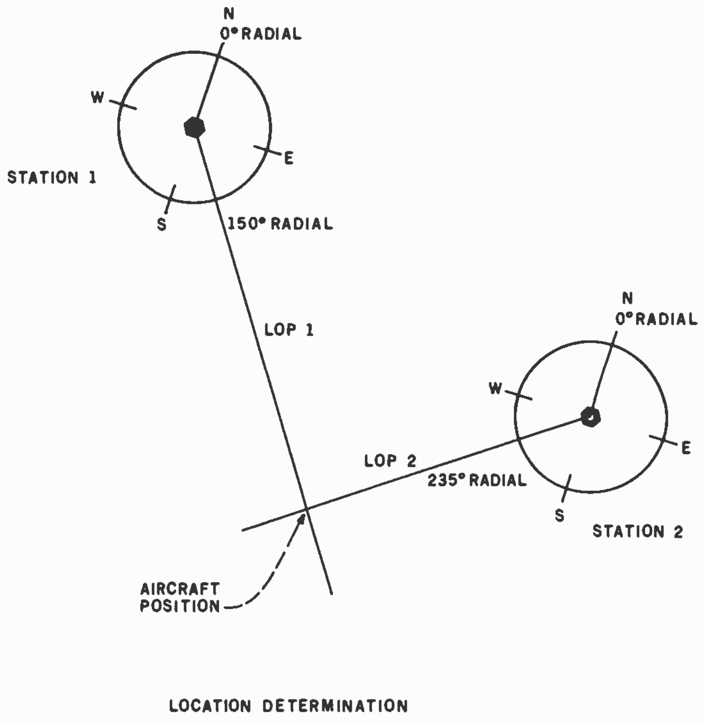

Figure 1: *An aircraft's position may be determined using two VOR or Omni navigation stations. By drawing the respective radials, the pilot can plot the current location as the intersection of two lines on a map.*

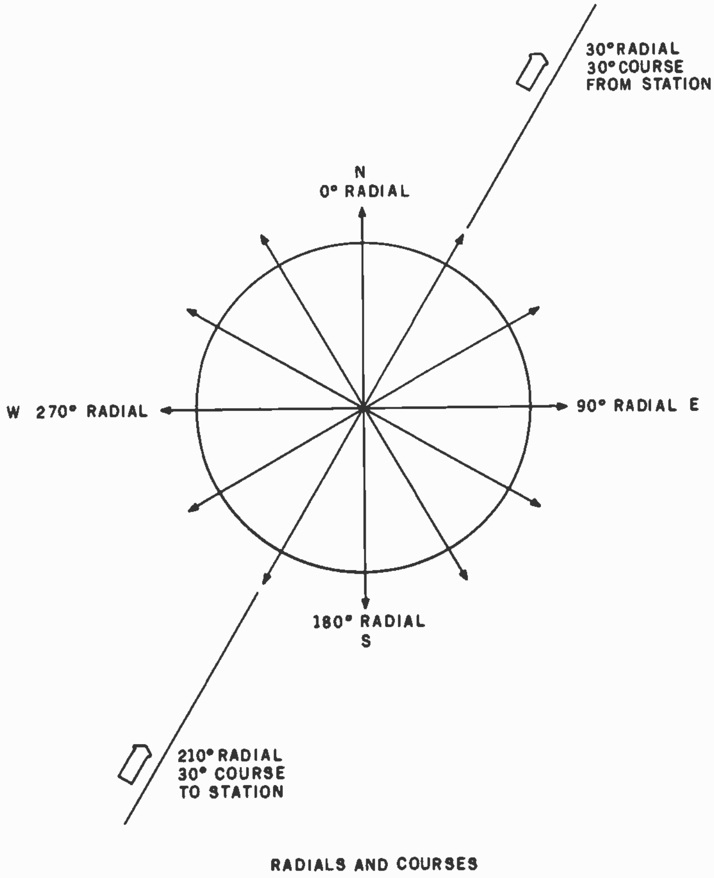

Figure 2: *Standard layout for the radials as broadcast by a VOR station. Note that an aircraft traveling along the line is on a course 180° opposite the value of the radial when it is heading to the station.*

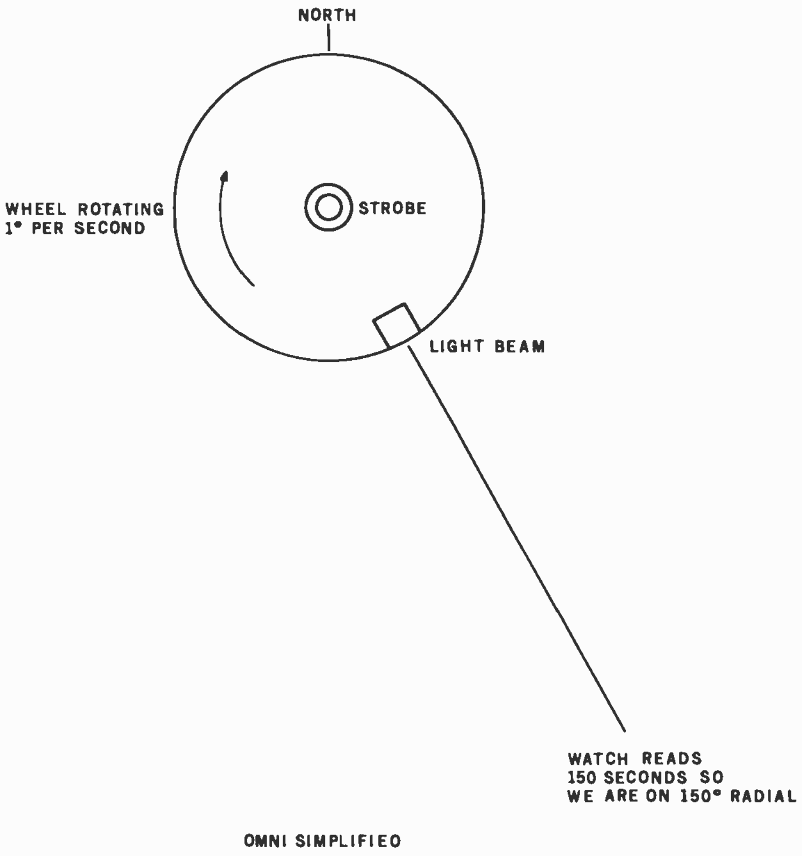

Figure 3: *This simplified model diagrams the function of the VOR aircraft navigation receiver. In this model, the wheel rotates clockwise one degree per second, and a strobe light flashes when the radial beam is at 0°. The current radial is found by counting the number of seconds between the flash of the strobe and the sighting of the radial light beam.*

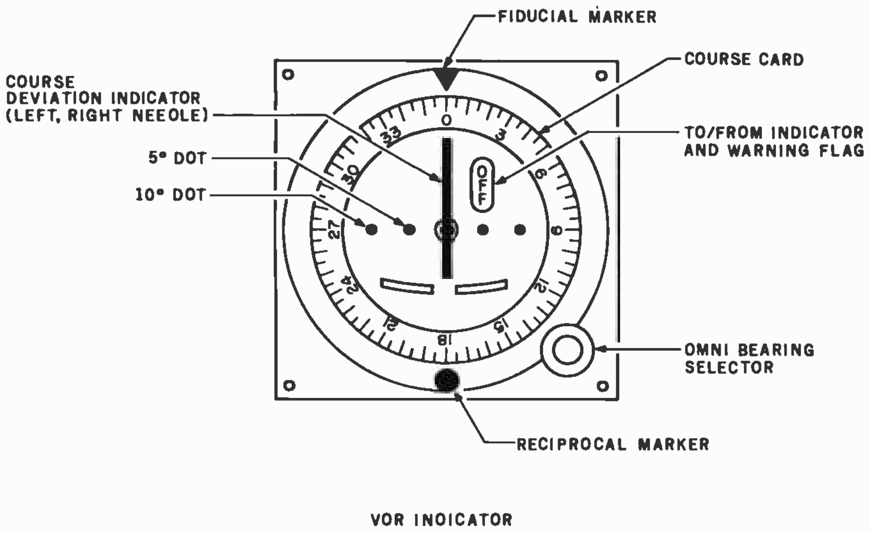

Figure 4: *Layout of a typical VOR indicator. The course card is rotated via the Omni Bearing Selector until the Course Deviation Indicator is centered. The value indicated by the fiducial marker is the aircraft's direction relative to the Omni station.*

strobe light. A lamp shining outward with a highly directional beam is mounted on the edge of the wheel. The wheel rotates at one degree per second, and the strobe blinks when the lamp on the wheel is pointing due north. To determine what radial you are on, start your stopwatch when you see the strobe flash, and stop it when you see the light on the wheel. The number of seconds on your watch is the radial where you are located (see figure 3).

Instead of a stopwatch, the pilot of an airplane uses a navigation receiver with a VOR indicator (see figure 4). Assume that you, the pilot, wish to fly directly to the station. You turn the OBS (Omni Bearing Selector), causing the *course card* to rotate. The card rotates until the CDI (Course Deviation Indicator) centers. Next you examine the *To/From* flag. If it says "From", the plane's position is on the radial shown under the fiducial marker—a course taking it directly away from the station.

Because you want to go *toward* the station, you must keep turning the card until the needle again centers (a 180° rotation) and the flag reads "To". If the flag read "To" the first time the needle centered, you would have left the OBS alone. The course shown under the fiducial marker is the direction in which you must turn the airplane to go to the station. It's also the reciprocal of the radial of your position. As previously stated, you fly to the station by flying the reciprocal of the radial (because radials point out from the station).

Once the radial is determined, you point the airplane in the direction displayed and follow the needle (CDI) to the station. If the needle drifts left, turn left until it centers. In other words, if the needle points left, the plane is to the right of its intended course and vice versa. The 5° and 10° dots tell how far off course you are. This relationship holds true as long as the course under the fiducial marker is roughly the same as the aircraft heading. The needle shows aircraft location with regard to the selected course, but it shows nothing about the aircraft heading. It's up to the

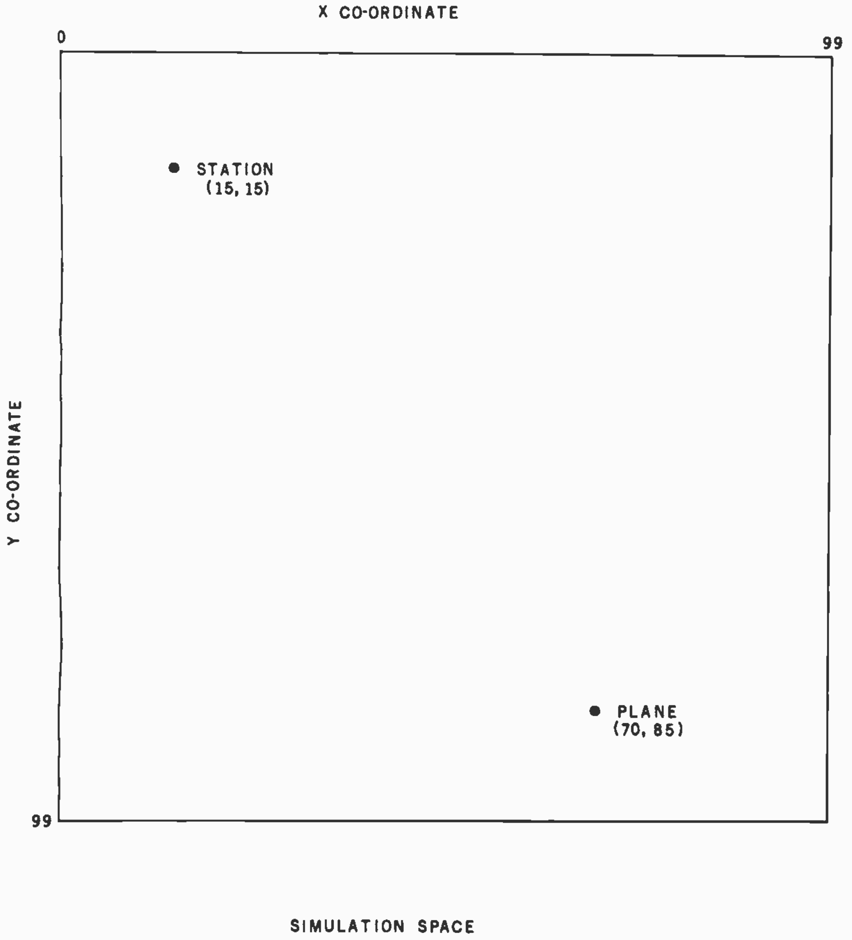

Figure 5: *Possible computer display of the relative locations of a target aircraft and an Omni station for a simulation of actual operation. Note that the coordinate origin is at the top left of the simulation space.*

pilot to control the aircraft so that the VOR indicator readings make sense.

Assuming you hold your course straight to the station, sooner or later you will fly directly over it, into an area called the "Cone of Confusion." The To/From flag gets highly agitated, settling down to a "From" reading once the plane passes the station. You are now on the actual radial shown on the indicator. As long as you follow the needle, you will fly directly away from the station.

As you may have gathered by now, it's no easy task to learn to use this system while also flying an airplane. The program given in listing 1 simulates the Omni system, allowing you to learn and practice without using fuel in the calm privacy of your computer area.

How It Works

The small world in which our simulated flying takes place is a 100-point by 100-point square (see figure 5). The *y* scale is inverted from normal (with the origin at the top left of the space), as in an Apple II. One point is chosen as the location of the Omni station, another as the airplane's current position. When provided with the course set on the VOR indicator, the program computes the radial, To/From flag, and CDI display.

The program starts with remarks, then jumps past a group of subroutines to the main routine. The subroutines are at the front to speed up operation of the program. The main routine consists only of a sequence of subroutine calls.

Subroutine 1 first requests both the coordinates of the station and the aircraft location. In both cases, it needs the *x* coordinate first, followed by the *y* coordinate. Subroutine 2 inputs the numbers, making sure the number in-

Listing 1: *Program that emulates the operation of the Omni Aviation Navigation System. Using a Cartesian-coordinate space to calculate the relative positions of two specified points in that space (an aircraft and a VOR station), the program determines the radial of the first point relative to the second. Note that the variable O is used for user input of the Omni Bearing Selector setting.*

```
10 REM THIS IS A PROGRAM TO EMULATE AN OMNI NAVIGATION SYSTEM
20 REM
30 REM OMNI1 01/17/80
40 REM
50 GO TO 1430
60 REM *** SUBROUTINE 1 ***
70 REM GET CO-ORDINATES OF OMNI STATION
80 PRINT "INPUT X CO-ORDINATE OF STATION";
90 GOSUB 660
100 XO=N
110 PRINT "INPUT Y CO-ORDINATE OF STATION";
120 GOSUB 660
130 YO=99-N
140 PRINT "INPUT X CO-ORDINATE OF AIRCRAFT";
150 GOSUB 660
160 X1=N
170 PRINT "INPUT Y CO-ORDINATE OF AIRCRAFT";
180 GOSUB 660
190 Y1=99-N
200 REM REDUCE ORIGIN TO O AND DETERMINE QUADRANT
210 X2=X1-XO
```

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Listing 1 continued:

```
220 Y2=Y1-Y0
230 REM CHECK FOR SPECIAL ZERO CASE
240 IF X2<>0 THEN 290
250 IF Y2>0 THEN R=0
260 IF Y2<0 THEN R=180
270 IF Y2=0 THEN R=0
280 GO TO 630
290 IF Y2<>0 THEN 340
300 IF X2>0 THEN R=90
310 IF X2<0 THEN R=270
320 IF X2=0 THEN R=0
330 GO TO 630
340 REM FIGURE QUADRANT
350 IF X2>0 THEN 430
360 IF Y2>0 THEN 400
370 REM BOTH X & Y NEGATIVE
380 Q=3
390 GO TO 490
400 REM X NEG, Y POS
410 Q=2
420 GO TO 490
430 IF Y2>0 THEN 470
440 REM X POS, Y NEG
450 Q=4
460 GO TO 490
470 REM X POS, Y POS
480 Q=1
490 REM COMPUTE PRIMARY ANGLE USING ABSOLUTE X&Y
500 REM ANGLE=ARCTAN OF OPPOSITE/ADJACENT
510 REM CONVERT TO DEGREES RADIANS*180/PI
520 P=ATN((ABS(Y2)/ABS(X2)))*180/PI
530 ON Q GO TO 540,570,590,610
540 REM COMPUTE RADIAL
550 R=90-P
560 GO TO 630
570 R=270+P
580 GO TO 630
590 R=270-P
600 GO TO 630
610 R=90+P
620 GO TO 630
630 PRINT " THE RADIAL WE ARE ON IS";
640 PRINT R
650 RETURN
660 REM *** SUBROUTINE 2 ***
670 INPUT N
680 IF N>99 THEN 670
690 IF N<0 THEN 670
700 RETURN
710 REM *** SUBROUTINE 3 ***
720 REM GET OBS SETTING
730 PRINT "INPUT THE OBS SETTING"
740 INPUT O
750 IF O<0 THEN 730
760 IF O>360 THEN 730
770 RETURN
780 REM *** SUBROUTINE 4 ***
790 REM REDUCE RADIAL R TO STANDARD CIRCLE(OBS=0)
800 R=R-O
810 IF R<0 THEN R=R+360
820 REM SET TO/FROM FLAG F
830 REM 1=OFF, 2=TO, 3=FROM
840 IF X2<>0 THEN 890
```

Listing 1 continued on page 474

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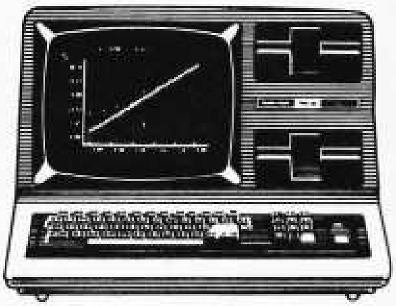

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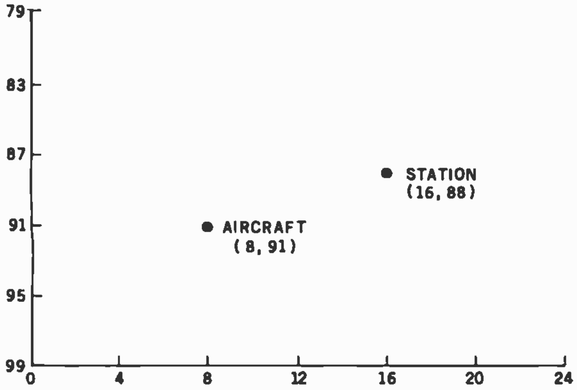
Listing 1 continued:

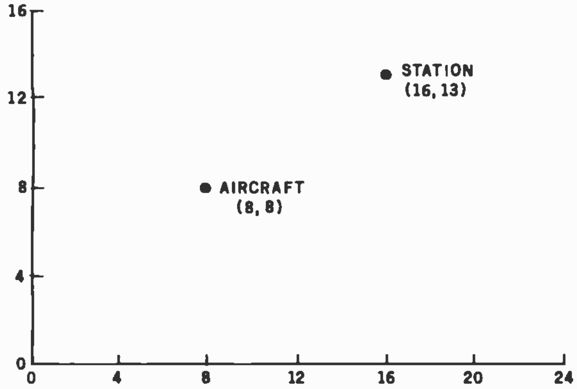
```
850 IF Y2<>0 THEN 890
860 F=1
870 REM FLAG IS OFF DIRECTLY OVER STATION
880 RETURN
890 IF R<>90 THEN 920
900 F=1
910 RETURN
920 IF R<>270 THEN 950
930 F=1
940 RETURN
950 IF R<>0 THEN 980
960 F=3
970 RETURN
980 IF R<>180 THEN 1010
990 F=2
1000 RETURN
1010 IF R<90 THEN 1050
1020 IF R>270 THEN 1050
1030 F=2
1040 RETURN
1050 F=3
1060 RETURN
1070 REM *** SUBROUTINE 5 ***
1080 REM FIGURE LEFT/RIGHT NEEDLE N
1090 REM ON A SCALE OF 0 TO 10
1100 REM WITH 0=LEFT, 5=CENTER, 10=RIGHT
1110 IF R<>0 THEN 1140
1120 N=5
1130 RETURN
1140 IF R<>180 THEN 1170
1150 N=5
1160 RETURN
1170 IF R>180 THEN 1260
1180 REM PROCESS LEFT NEEDLE
1190 IF R>90 THEN 1230
1200 IF R>10 THEN R=10
1210 N=(10-R)/2
1220 RETURN
1230 IF R<170 THEN R=170
1240 N=5-((180-R)/2)
1250 RETURN
1260 IF R<350 THEN 1290
1270 N=((360-R)/2)+5
1280 RETURN
1290 IF R>190 THEN R=190
1300 N=((R-180)/2)+5
1310 RETURN
1320 REM *** SUBROUTINE 6 ***
1330 ON F GO TO 1340, 1360, 1380
1340 PRINT "OFF"
1350 GO TO 1390
1360 PRINT "TO"
1370 GO TO 1390
1380 PRINT "FROM"
1390 PRINT "¦¦¦¦¦O¦¦¦¦¦"
1400 PRINT TAB(N);"*"
1410 RETURN
1420 REM *** MAIN PROGRAM ***
1430 GOSUB 60
1440 GOSUB 710
1450 GOSUB 780
1460 GOSUB 1070
1470 GOSUB 1320
```

(6a)



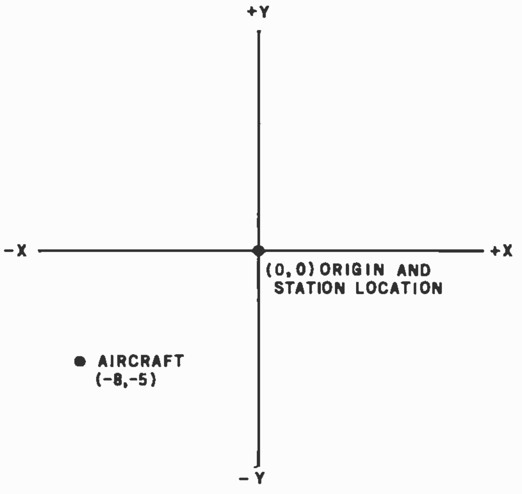
RAW DATA

(6b)



REDEFINE Y SCALE BY SUBTRACTING FROM 99

(6c)



CONVERT TO CARTESIAN CO-ORDINATES BY SUBTRACTING STATION CO-ORDINATES FROM AIRCRAFT'S

Figure 6: *Procedure followed by the program in listing 1 to transform the coordinate information into a form from which the actual radial may be calculated. 6a gives the raw data as displayed on a computer screen. In 6b the y coordinates have been converted to a normal scale by subtracting their values from 99. Finally, the space is converted to a standard Cartesian space with the VOR station at the origin by subtracting the station coordinates from the aircraft's position.*

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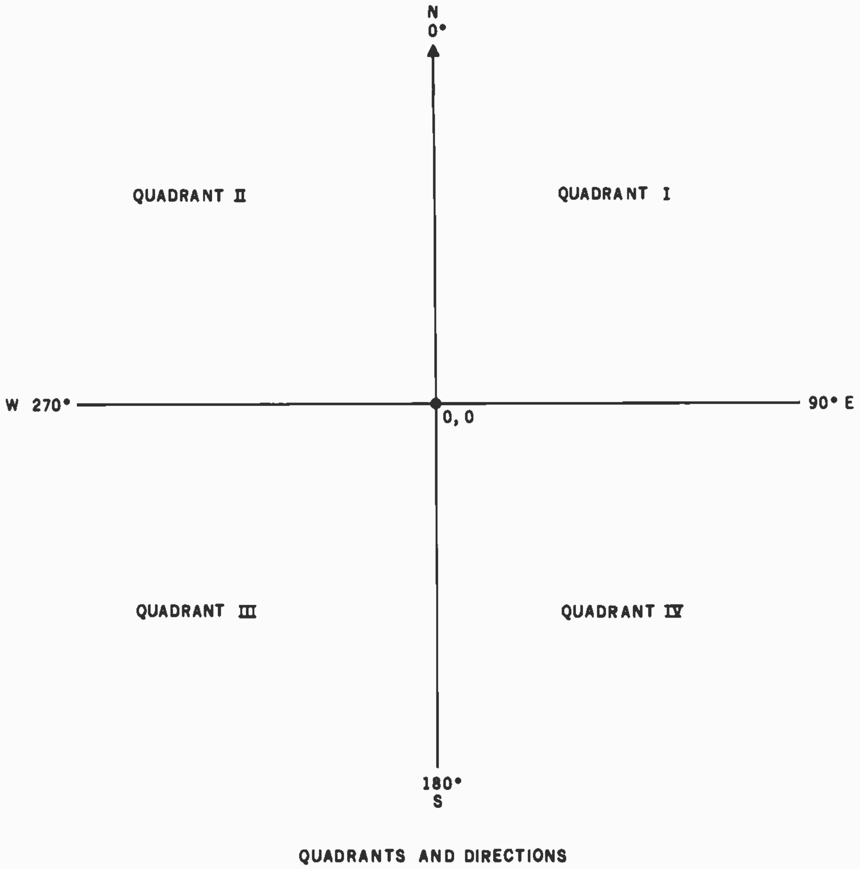


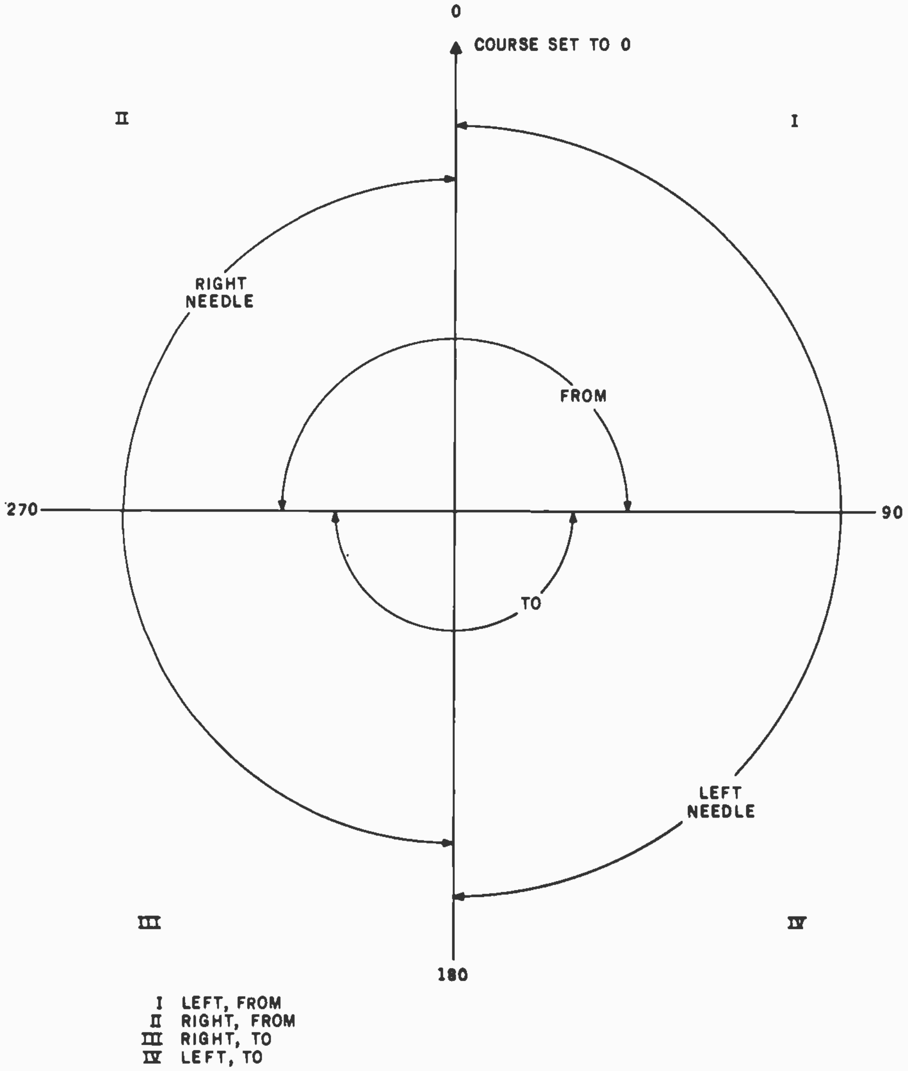
Figure 7: *Standard Cartesian coordinate space as used with the Omni system.*

put is not less than 0 or greater than 99. The program will simply request another number if an out-of-range response is given. Since the y coordinate is upside-down compared to a normal system, the y input is subtracted from 99 to compensate. Next, subtract the station's x coordinate (X0) from the airplane's x (X1) and the station's y (Y1). This operation adjusts the whole coordinate system to a standard four-quadrant Cartesian plane, with the station at the origin (figure 6). Notice that the relationship between the airplane and the station does not change during the transformations. Only the labels of the points' positions change. X2 and Y2 now define the aircraft location.

A Cartesian coordinate system is divided into four quadrants. In this program, the dividing lines between the quadrants are considered the four cardinal compass points (see figure 7). To determine which radial you are on, you must know the quadrant of your location. Before finding the quadrant, however, you must test for the special case of being *on* one of the cardinal lines. You can accomplish this by testing for x or y equal to 0. If x is 0 and y is positive, you are on the 0° radial. If x is 0 and y is negative, you are on the 180° radial; if y is 0 and x is positive, the 90° radial; and if y is 0 and x is negative, the 270° radial. If both are 0, you are directly over the station. If you are indeed on a cardinal radial, you can print which radial it is and exit subroutine 1.

If you are not on a cardinal radial, use the following test to determine your quadrant (Q). Both x and y positive means quadrant 1; x and y both negative means quadrant 3, x positive and y negative means quadrant 4; and x negative, y positive means quadrant 2. After this test, Q equals 1, 2, 3, or 4, and this number is used to perform an n-way branch to compute the final radial. The next step toward your radial is finding the primary angle using the absolute values of x and y (now labeled X2, Y2). This primary angle, labeled P, is computed with the formula:

$$P = \frac{\text{arctan (opposite side)}}{\text{adjacent side}}$$



CDI AND TO/FROM DETERMINATION USING STANDARD CIRCLE

Figure 8: *Cartesian representation of the interaction of the Course Deviation Indicator and the To/From Indicator used to determine the heading of an aircraft relative to a given VOR radial, in this case 0.*

Because my computer, a Digital Equipment Corporation PDP-11/45, thinks in radians, I convert to degrees by multiplying by 180 and dividing by π. The final BASIC equation looks like this:

```
P = ATN((ABS(Y2)/ABS(X2)))
     *180/PI
```

With the primary angle computed, we can do our branch on Q and find the final radial (R). If Q is 1, R equals 90 − P. If Q is 2, R equals 270 + P. For a Q of 3, R is 270 − P, and for a Q of 4, R equals 90 + P. The last step of subroutine 1 is to print out the radial computed.

Now that the program knows the radial of the airplane's location, you can compare that to the selected course, generate the CDI position, and compute the To/From flag reading. Subroutine 3 gets the ball rolling by requesting the OBS setting (O), which must be between 0 and 360 if you don't want the program to reprompt for input.

The CDI and To/From displays would be easier to understand if they were based on a standard circle with the OBS set to 0 (see figure 8). Subroutine 4 adjusts the current radial to standard form by rotating R the same number of degrees needed to set the OBS to 0. If R goes negative, it's added to 360 to keep the value positive. The To/From flag (F) can now be set to 1 for Off, 2 for To, or 3

for From. X2 and Y2 are checked to see if they both equal 0. If so, the plane is directly over the station, and the flag is set to Off. If they don't equal 0, you compute To or From. According to the standard circle, a radial from 271 to 89 is a From, while a radial from 91 to 269 is a To. Radials of 90 and 270 both rate an Off, since the plane is directly abeam the station. Subroutine 4 follows these rules and returns with F set appropriately.

Your last major task is to determine a needle value (N) to figure out the position of the CDI. A needle value of 0 is full left, 5 is center, and 10 is full right. Using a tab statement, the needle position will control the position of an asterisk which will appear under a scale marked at 2° intervals. The positions correspond to CDI needle position on a real VOR indicator.

Subroutine 5 does the chore of deciding the value of N. First it checks for a radial of 0° or 180°, either of which would center the needle and set N equal to 5. Next, the subroutine decides if it's a left or right needle by seeing in which half of the standard circle the radial falls. Once this is checked, you must look for a difference of more than 10° between the radial and the 0°-to-180° line. If the difference exceeds 10°, the needle makes a full-scale deflection, setting N to either 0 or 10, depending on direction. With N computed, subroutine 6 prints the proper To/From flag value and the course deviation indication. This marks the end of the program.

Modifications

This program lends itself very well to a computer with a graphic display, such as the Apple II. The high-resolution graphics mode can be used to show the simulation space, and you could write a routine using the game paddles to position the airplane in the space. One paddle button would mark the station location, and the other could cause the OBS setting to automatically increment. The To/From flag and CDI could also be animated with graphics, and the program could run continuously. As the airplane moves around the station, the VOR indicator would give the same indications it would provide under actual flying conditions. You could also add another station for practicing such navigation problems as identifying airway intersections.

Conclusion

Would-be pilots can familiarize themselves with the basics of VOR operation by running this simulation of the Omni navigation system. You can make the program more realistic by adding a second VOR station as suggested. Although this simulator provides invaluable experience for pilot trainees, it can become an entertaining and informative game for nonpilots with the addition of improved graphics and an operational theme. Simulation is an exciting computer application that combines the serious, the technical, and the enjoyable.■

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The Denver Amateur Computer Society (DACS) meets on the third Wednesday of each month at the Educational Plaza, 7350 North Broadway, North Denver, Colorado. Meeting time is 7 p.m. Meetings are made up of workshops or tutorial sessions, business, and formal presentations or demonstrations. The club produces a newsletter, *Interrupt*, which is packed with notes from special-interest groups, news of other clubs' activities, and tutorials. Annual dues are $12. This broad-interest group can be contacted at POB 1235, Englewood, CO 80150.

ACS

The Atlanta Computer Society's (ACS's) monthly publication, *The ACS Newsletter*, is filled with tips on better programming, news of club activities, and product reviews. The ACS members have established a number of active special-interest groups, including ones for 8080/Z80, 6800 series, Apple, and Atari microcomputers as well as a robotics group. Other club interests are maintaining a program library and a CBBS (computerized bulletin-board system), which can be contacted by calling (404) 394-4220. Contact the ACS, POB 888771, Atlanta, GA 30356.

IBM Group Forming

A users group for the IBM Personal Computer is being formed in the Anaheim area. For details, contact Bob Martynec, 2633 East La Palma, Apt. 8, Anaheim, CA 92806, (714) 776-9376.

Atari Group in Orange County

The Atari Computer Association of Orange County meets on the third Tuesday of each month at the Allstate Savings and Loan in Westminster, California. The group produces a newsletter that has summaries of club meetings, tips on better Atari programming, and book reviews. For details, contact the Atari Computer Association of Orange County, Suite 150, 141 Westminster Mall, Westminster, CA 92683.

Public-Domain Pascal Software

The Pascal/Z Users Group is a nonprofit organization that maintains a large body of public-domain software. Most of the software is geared toward the Pascal user, but some software is available in source and COM files and Z80 assemby language. In single-sided single-density IBM soft-sectored format, the disks cost $10, postage paid. Your purchase includes a commitment to reply by return mail. A list of available software can be obtained by sending the club a large, self-addressed envelope with two stamps. The group also produces the bimonthly *Pascal/Z Users Group Newsletter*, which is available for $9 a year. The newsletter has information on Pascal-related products, industry news, and letters from readers. Contact the Pascal/Z Users Group, 7962 Center Parkway, Sacramento, CA 95823. ■

Books Received

Apple BASIC: Data File Programming, A Self-Teaching Guide, Leroy Finkel and Jerald R. Brown. New York: John Wiley & Sons, 1982; 303 pages, 15.5 by 23 cm, softcover, ISBN 0-471-09157-X, $12.95.

Applied Multidimensional Systems Theory, N. K. Bose. New York: Van Nostrand Reinhold, 1982; 411 pages, 14.6 by 22.3 cm, hardcover, ISBN 0-442-27214-6, $29.50.

Business Data Processing, 2nd edition, Barbara J. Burian and Stuart S. Fink. Englewood Cliffs, NJ: Prentice-Hall, 1982; 494 pages, 17.5 by 23.5 cm, hardcover, ISBN 0-13-094045-3, $18.95.

Computer Capacity, A Production Control Approach, Melvin J. Strauss. New York: Van Nostrand Reinhold, 1981; 265 pages, 17.5 by 25.5 cm, hardcover, ISBN 0-442-26243-4, $24.95.

Computer Choices, Beware of Conspicuous Computing, H. Dominic Covvey and Neil Harding McAlister. Reading, MA: Addison-Wesley, 1982; 225 pages, 14.6 by 22.3 cm, softcover, ISBN 0-201-10113-0, $8.95.

Digital Principles and Applications, 3rd edition, Albert P. Malvino and Donald P. Leach. New York: Gregg/McGraw-Hill, 1981; 490 pages, 14.6 by 22.3 cm, hardcover, ISBN 0-07-039875-5, $24.10.

Interfacing Microcomputers to the Real World, Murray Sargent III and Richard L. Shoemaker. Reading, MA: Addison-Wesley, 1981; 288 pages, 15.5 by 23 cm, softcover, ISBN 0-201-06879-6, $14.95.

Introduction to Microcomputer-Based Digital Systems, James W. Gault and Russell L. Pimmel. New York: McGraw-Hill, 1982; 429 pages, 15.5 by 23 cm, hardcover, ISBN 0-07-023047-1, $26.95.

Local Networks, W. R. Franta. Lexington, MA: Lexington Books, 1981; 481 pages, 15.5 by 22.5 cm, hardcover, ISBN 0-669-03779-6, $39.95.

Management by Multiple Objectives, A Modern Management Approach, Sang M. Lee. Princeton, NJ: Petrocelli Books, 1981; 225 pages, 14.6 by 22.3 cm, hardcover, ISBN 0-89433-083-7, $17.50.

Microprocessor Applications Handbook, David F. Stout. New York: McGraw-Hill, 1981; 464 pages, 15 by 23 cm, hardcover, ISBN 0-07-061798-8, $35.

Microprocessors for Measurement and Control, David M. Auslander and Paul Sagues. Berkeley, CA: Osborne/McGraw-Hill, 1981; 310 pages, 18.3 by 23 cm, softcover, ISBN 0-931988-57-8, $15.99.

Microprogramming, Concepts and Techniques, Ben E. Cline. Princeton, NJ: Petrocelli Books, 1981; 169 pages, 14.6 by 22.3 cm, hardcover, ISBN 0-89433-133-7, $20.

The Micro Revolution, Living with Computers, Peter Laurie. New York: Universe Books, 1981; 225 pages, 13 by 20.5 cm, softcover, ISBN 0-87663-560-5, $7.95.

Pascal Program Development with Ten Instruction Pascal Subsets (Tips) and Standard Pascal, Michael Kennedy and Martin B. Solomon. Englewood Cliffs, NJ: Prentice-Hall, 1982; 532 pages, 16.5 by 22.5 cm, softcover, ISBN 0-13-652735-3, $17.95.

PET/CBM BASIC, Richard Haskell. Englewood Cliffs, NJ: Prentice-Hall, 1982; 154 pages, 20.6 by 27.3 cm, softcover, ISBN 0-13-661751-4, $12.95.

PET Games and Recreations, Mac Oglesby, Len Lindsay, and Dorothy Kunkin. Reston, VA: Reston Publishing, 1981; 245 pages, 14.6 by 22.3 cm, softcover, ISBN 0-8359-5529-X, $9.95.

Problem-Solving on the TRS-80 Pocket Computer, A Self-Teaching Guide, Don Inman and Jim Conlan. New York: John Wiley & Sons, 1982; 255 pages, 18.3 by 23 cm, softcover, ISBN 0-471-09270-3, $8.95.

Programming Language Translation, R. E. Berry. New York: Halsted Press, 1981; 175 pages, 14.6 by 22.3 cm, hardcover, ISBN 0-470-27305-4, $41.95.

Queuing Theory: A Problem-Solving Approach, Leonard Gorney. Princeton, NJ: Petrocelli Books, 1981; 184 pages, 15 by 23 cm, hardcover, ISBN 0-89433-128-0, $20.

Real Time Programming–Neglected Topics, Caxton C. Foster. Reading, MA: Addison-Wesley, 1981; 190 pages, 23 by 15.5 cm, softcover, ISBN 0-201-01937-X, $9.95.

Software Manual for the Elementary Functions, William J. Cody Jr. and William Waite. Englewood Cliffs, NJ: Prentice-Hall, 1980; 269 pages, 15 by 23 cm, hardcover, ISBN 0-13 822064-6, $17.95.

Software Engineering Economics, Barry W. Boehm. Englewood Cliffs, NJ: Prentice-Hall, 1981; 767 pages, 23.5 by 17.5 cm, hardcover, ISBN 0-13-822122-7, $32.50.

Structured BASIC Programming for Business, 2nd edition, V. Thomas Dock. St. Paul, MN: West Publishing, 1982; 131 pages, 18 by 24 cm, softcover, ISBN 0-314-63167-4, $11.95.

Understanding Microprocessors, B. S. Walker. New York: Halsted Press, 1982; 110 pages, 14.6 by 22.3 cm, softcover, ISBN 0-470-27286-4, $12.95.

The TRS-80 Means Business, Ted G. Lewis. New York: John Wiley & Sons, 1982; 194 pages, 15.5 by 23 cm, softcover, ISBN 0-471-08239-2, $12.95.

Understanding Computer Systems, Harold W. Lawson Jr. Rockville, MD: Computer Science Press, 1981; 164 pages, 15.5 by 23 cm, softcover, ISBN 0-914894-31-5, $9.95.

Using Programmable Calculators for Business, C. Louis Hohenstein. New York: John Wiley & Sons, 1982; 296 pages, 15.5 by 23 cm, softcover, ISBN 0-471-08551-0, $10.95.■

This is a list of books received at BYTE Publications during this past month. Although the list is not meant to be exhaustive, its purpose is to acquaint BYTE readers with recently published titles in computer science and related fields. We regret that we cannot review or comment on all the books we receive; instead, this list is meant to be a monthly acknowledgment of these books and the publishers who sent them.

BYTE's Bugs

Tree Searching Yields Bugs

In Gregg Williams's article, "Tree Searching" (see the September 1981 BYTE, page 76), he stated, ". . . it is clear that the shortest route is ADBC, with a distance (cost) of thirteen." My calculations arrive at ADCB as the shortest route with a cost of twelve.

Michael L. Steiner, M.D.
Suite 100
3044 Sunset Ave.,
Rocky Mount, NC 27801■

1 Infinity 2 Einstein Universe 3 Nesting Tree

Three in a series of t-shirts by Scott Kim

What happens when you mix computer graphics, letters and illusion?

Inversions.

Wear one and your next encounter may be the one that goes beyond words.

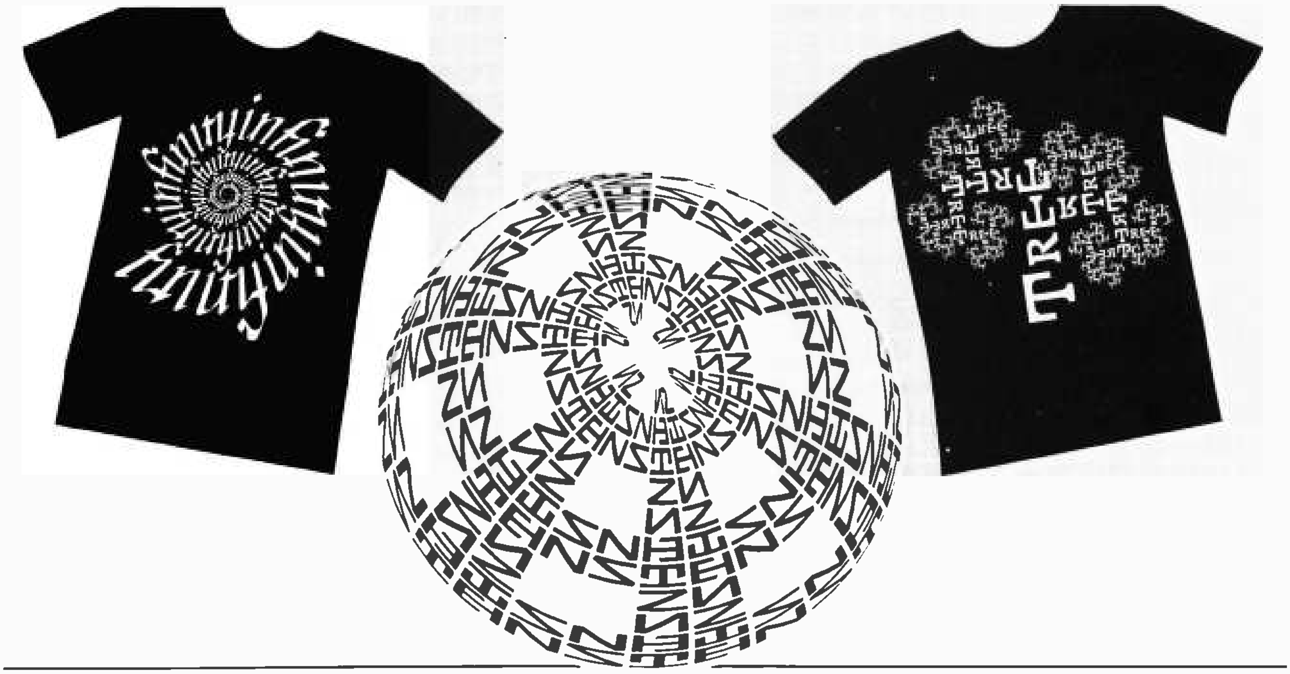
More than 60 original inversions can be seen in the new book, **Inversions:** A Catalog of Calligraphic Cartwheels by Scott Kim. **Inversions** is available through your local bookstore or by calling Byte Books' toll-free number, 800/258-5420.

> *"Scott Kim's* Inversions*... is one of the most astonishing and delightful books ever printed... Over the years Kim has developed the magical ability to take just about any word or short phrase and letter it in such a way that it exhibits some kind of striking geometrical symmetry."*
> **— Martin Gardner,**
> Scientific American

Infinity:
☐ white on black
☐ black on white

Einstein Universe:
☐ black/violet on gray*
☐ black/lt. blue on white

Nesting Tree:
☐ reds/oranges on tan
☐ greens on navy



*All shirts are 100% cotton except gray, which is 50% cotton, 50% polyester.

1 Infinity
☐ black on white
__xs __s __m __l __xl
☐ white on black
__xs __s __m __l __xl

2 Einstein Universe
☐ black/violet on gray
__xs __s __m __l __xl
☐ black/lt. blue on white
__xs __s __m __l __xl

3 Nesting Tree
☐ reds/oranges on tan
__xs __s __m __l __xl
☐ greens on navy
__xs __s __m __l __xl

name
address
city
state zip

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Circle 77 on inquiry card.

Event Queue

June 1982

June
Cooperative Education Program, various sites throughout the U.S. This series of more than 100 data-processing courses is presented by Q. E. D. Information Sciences Inc. Course topics include systems development, structured methodologies, database, telecommunications, management, and human relations. These two- to five-day courses are tailored for analysts, designers, programmers, managers, and other users. For additional details, contact the Manager of Education Programs, Q. E. D. Information Sciences Inc., Q. E. D. Plaza, POB 181, Wellesley, MA 02181, (800) 343-4848; in Massachusetts, (617) 237-5656.

June
Courses and Seminars from Sira Institute, various sites throughout England. Sira Institute is sponsoring seminars on a wide variety of subjects, ranging from microprocessor familiarization to design and development of microprocessor-based equipment. For details, contact Conferences & Courses Unit, Sira Institute Ltd., South Hill, Chislehurst, Kent BR7 5EH, England.

June
Datamation Institute Seminars on Information Management, various sites throughout the U.S. Databases and communications, systems performance, data-processing management, word processing, office automation, computer graphics, and topics of general interest are among the areas to be covered by these two-day seminars. Fees range from $495 to $595. For schedules of times and places, contact Karen Smolens, the Center for Management Research, Datamation Institute Seminar Coordination Office, 850 Boylston St., Chestnut Hill, MA 02167, (617) 738-5020.

June
Education and Training Seminars, various sites throughout the U.S. and Europe. Among the seminar topics offered by STSC Inc. and APL*Plus International are "Nested Arrays," "Intermediate APL," and "Advanced APL Programming Techniques." For complete details on these and other seminars, contact the Seminar Administrator, STSC Inc., 11 Clearbrook Rd., Elmsford, NY 10523, (914) 347-5560. In Europe, contact APL*Plus International, Tour Neptune, Cedex N°20, 92086 Paris La Défense, France, Tel: 773.79.64.

June
Intensive Two-day Seminars for Professional Development, various sites throughout New England. Among the seminars to be offered by Worcester Polytechnic Institute are "Fundamentals of Data Processing," "Distributed Systems: The Architecture and Utilization of this Revolutionary Technology," and "Microprocessors: Hardware, Software, and Applications." Registration fees range from $445 for a two-day program to $990 for a seven-day executive institute. For complete details, contact Ms. Ginny Bazarian, Office of Continuing Education, Worcester Polytechnic Institute, Worcester, MA 01609, (617) 793-5517.

June
Knowledge Engineering in the 1980s, Chicago, IL. Expert Systems are computer programs that reason in tasks that require considerable human expertise, such as locating computer malfunctions, monitoring intensive care patients, analyzing noisy signal data, and diagnosing medical problems. This one-day executive briefing provides an introduction to the potential benefits and costs of Expert Systems. For further information, contact Dina Barr, Teknowledge, 151 University Ave., Palo Alto, CA 94301, (415) 326-6827.

June
The Master Method of Selling Small-Business Systems, Westlake Village, CA. This one-day seminar is designed for mini- and microcomputer manufacturers and software vendors who sell small-business systems. The seminar fee is $150. For details, contact Seminar Information, M. W. L. Inc., 32038 Watergate Court, Westlake Village, CA 91361, (213) 889-2607.

June
National Computer Graphics Association Seminar Program, various sites throughout the U.S. Topics include "Successful Business Graphics," "Business Graphics for Financial Analysis and Decision Making," and "Applications of Computer Graphics to Transportation Problems." Seminar fees are $395 for association members and $425 for nonmembers. For complete details, contact Eloise Wenker, NCGA Seminar, 2033 M St. NW, #300, Washington, DC 20036, (202) 466-4102.

June
One- and Two-day Professional Development Seminars, various sites in the greater Boston area. Among the courses being offered by Boston University are "Business Writing for Results," "Improving Customer Service," and "Assertive Management." Registration fees range from $295 for a one-day program to $445 for a two-day program. These seminars can be conducted within your company. For details, contact Ms. Joan Merrick, Center for Management Research, 850 Boylston St., Chestnut Hill, MA 02167, (617) 738-5020. For information on the in-company seminars, contact Ms. Elaine Dee at the same address.

June
Productivity '82, various sites throughout the U.S. and Canada. This two-day show features hands-on demonstrations of Hewlett-Packard's newest computer and application solutions ranging from personal and small-business computers to the top-of-the-line computer systems for office computing, distributed data processing, and factory automation. Sixteen different seminars are held each day on such topics as using personal computers, choosing financial and applications software, and preparing easy-to-read graphics. Additional information can be obtained from local Hewlett-Packard sales offices or from Rudanne Clark, Hewlett-Packard, 3000 Hanover St., Palo Alto, CA 94304, (415) 857-7247.

June
Sensors & Systems '82, various sites throughout the central and western regions of the U.S. This series of three-day conferences will cover all aspects of sensor technology from temperature sensors through to displacement, velocity, acceleration, magnetic field, and moisture. Other topics to be covered include signal conditioning, digital interfaces, and system interfaces. Contact Network Exhibitions, 785 Harriet Ave.,

Campbell, CA 95008, (408) 370-1661.

June-July
Courses from Integrated Computer Systems, various sites throughout the U.S. Among the courses being offered are "Microprocessor Software, Hardware, and Interfacing," "Hands-on Microprocessor Troubleshooting," "Speech Synthesis and Recognition," and "Digital Image Processing and Analysis." Complete course listings including dates, locations, course outlines, and fees are available from Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (800) 421-8166; in California, (800) 352-8251.

June-July
Meetings, Seminars, and Programs from the Electronic Industries Association (EIA), various sites throughout the U.S. Among the events planned are the Government/Industry Executive Roundtable '82 and a symposium on "Telecommunications: Trends and Directions." Contact EIA, 2001 Eye St. NW, Washington, DC 20006, (202) 457-4981.

June-July
Technical Classes from Zilog, Campbell, CA. Zilog is offering a series of one- to five-day technical classes at its California-based training facility. Topics range from "Microprocessors: A General Introduction" to "Zeus/System 8000 User." Contact Zilog, Training and Education Dept., 1315 Dell Ave., Campbell, CA 95008, (408) 446-4666.

June-July
New York University SEHNAP Summer Sessions, New York University, New York, NY. Among the courses being offered by the School of Education, Health, Nursing, and Arts Professions (SEHNAP) are "Computer Graphics for Instruction," "Microcomputer Technology I," and "New Technology for Interactive and Individualized Instruction." These graduate-level courses are designed for teachers, administrators, and other professionals. For more information, contact NYU-SEHNAP Summer Sessions, 60 Press Building, New York University, New York, NY 10003, (212) 598-2772.

June-August
Database Concepts and Design, various sites throughout the U.S. Sponsored by the American Management Associations (AMA), this five-day seminar is designed for data-processing managers, system designers, and other personnel involved in database activities. Topics include an overview of the database environment; evaluating and measuring performance, costs, and results; determining organizational needs and the systems and software to meet them; and implementing, integrating, and supporting the database within company plans and budget. Highlighting this seminar is a comprehensive review of database products. Individual fees are $850 for AMA members and $975 for nonmembers. Team discounts are available. Contact AMA, 135 West 50th St., New York, NY 10020, (212) 586-8100. To register by phone, call (212) 246-0800.

June-August
Engineering Summer Conferences, Chrysler Center for Continuing Engineering Education, North Campus, University of Michigan, Ann Arbor, MI. Among the conferences being offered are "Interactive Design with Computers," "Applied Numerical Methods," and "Robotics: Concepts, Theory, and Applications." For complete details, contact Engineering Summer Conferences, 200 Chrysler Center, North Campus, University of Michigan, Ann Arbor, MI 48109, (313) 764-8490.

June 9-11
The International Conference on Consumer Electronics (ICCE), Arlington Park Hilton, Arlington Heights, IL. The technical program will include papers and panel discussions on such topics as personal computing, computer-aided design techniques, home information systems, and videotex, teletext, videodisc, video-cassette recorders, and cameras. Exhibits will be featured. This conference is sponsored by the Consumer Electronics Group of the IEEE (Institute of Electrical and Electronics Engineers). Contact the IEEE, 445 Hoes Lane, Piscataway, NJ 08854.

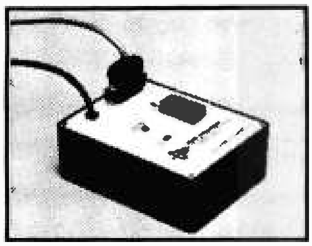
June 11-13
South Florida Microcomputer Conference and Exhibition, Broward Community College, North Campus, Fort Lauderdale, FL. This show will feature low-cost seminars, a trade show, and a used-computer flea market. The focus will be on the use of computers in small businesses, education, science and engineering, and word processing, as well as on hobbyist and consumer concerns. For details, contact Tom Blayney, Emergent Inc., 9466 Saddlebrook Dr., Boca Raton, FL 33434, (305) 483-5248.

June 13-16
The Fifteenth Annual Conference of the Association of Small Computer Users in Education, Chatham College, Pittsburgh, PA. This conference will include papers and demonstrations on the educational and administrative uses of computers. Other topics include robotics, Pascal programming, computer literacy, and the use of packaged software in computer courses. For more information, contact Jan Carver, Computer Center, Chatham College, Pittsburgh, PA 15232, (412) 441-8200.

June 13-16
The 1982 American Society for Information Science (ASIS) Mid-Year Meeting, University of Tennessee, Knoxville, TN. The theme for this conference is "Information—The Critical Difference." Among the topics to be explored are linking information to the user, information as a commodity, quality assurance in information, and attributing value to information. Speakers, panel sessions, and technical sessions sponsored by special-interest groups will highlight this conference. For more details, contact ASIS, 1010 Sixteenth St. NW, Washington, DC 20036, (202) 659-3644.

June 13-17
NCGA '82, The Third Annual Conference and Exhibition of the National Computer Graphics Association (NCGA), Anaheim Convention Center, Anaheim, CA. This conference will feature more than 20 tutorials and 60 technical sessions. Computer graphics products will be exhibited. Presentations from business, government, and academic graphics experts will be featured. Contact the NCGA, Suite 330, 2033 M St. NW, Washington, DC 20036, (202) 466-5895.

June 14-16
The Fifteenth Power Modulator Symposium, Hyatt Regency Baltimore, Baltimore, MD. This symposium will focus on the technology, devices, and systems associated with rep-rated power



modulators, including switches, auxiliary devices, energy storage, radio-frequency systems, and low-frequency generators. For details, contact Leonard Klein, Palisades Institute for Research Studies Inc., 201 Varick St., New York, NY 10014, (212) 620-3377.

June 14-16
The Nineteenth Design Automation Conference, Caesars Palace, Las Vegas, NV. This conference will focus on the computer-aided design of digital systems. Topics of interest include analog circuits, architectural and mechanical design and analysis, design verification, simulation, physical design and layout, documentation, testing, and databases. Other conference features include workshops and commercial exhibits. For further information, contact Bryan Preas, VR Information Systems, 5818 Balcones Dr., Austin, TX 78731.

June 15-17
The 1982 IEEE MTT-S International Microwave Symposium, Hyatt Regency Hotel, Dallas, TX. The theme of this symposium is "Thirty Years of Microwaves." Papers and tutorials on a wide range of topics, including computer-aided design and measurement techniques, microwave field and network theory, as well as satellite communications/microwave systems, will be presented. Contact J. R. Griffin, Texas Instruments Inc., Mail Stop 3432, POB 405, Lewisville, TX 75067, (214) 462-5693.

June 15-17
The Office Automation Show/Conference, Barbican Centre, London, England. For details on this show and conference, contact Clapp & Poliak International, 7315 Wisconsin Ave., Washington, DC 20014, (301) 657-3090.

June 15-18
Electromagnetic Compatibility Workshop, Washington, DC. For details on this course, contact Don White Consultants Inc., State Route 625, POB D, Gainesville, VA 22065, (703) 347-0030.

June 16-18
The Twentieth Annual Meeting of the Association for Computational Linguistics, University of Toronto, Toronto, Ontario, Canada. This meeting features papers on syntax, computational semantics, discourse analysis and speech acts, machine translation, as well as the mathematical and theoretical foundations of computational linguistics. For additional information, contact Don Walker, Artificial Intelligence Center, SRI International, Menlo Park, CA 94025, (415) 859-3071.

June 20-25
DP Training Managers' Workshop, Chicago, IL. This workshop is intended for individuals with less than 18 months' experience in coordinating data-processing training programs. Participants will learn to establish in-house education programs that will meet management objectives and ensure a high return on their organization's investment in training. The registration fee is $850. Contact Linda Hubacek, Deltak Inc., 1220 Kensington Rd., Oak Brook, IL 60521, (312) 920-0700.

June 22-24
Electromagnetic Interference Control and Noise Mitigation in Power and Telephone Systems, Washington, DC. For details on this course, contact Don White Consultants Inc., State Route 625, POB D,

Gainesville, VA 22065, (703) 347-0030.

June 23-26
Productivity 82, Seattle University, Seattle, WA. This conference is sponsored by the Association for Computing Machinery (ACM) and the Canadian Information Processing Society (CIPS). Productivity 82 is designed to emphasize the use of computers to improve productivity in industry and in the office, as well as to improve productivity in the programming of computers. Papers and panel discussions will be featured. For more information, contact Productivity 82-ACM/CIPS, 10636 Main St. #276, Bellevue, WA 98004.

June 28-30
COMDEX/Spring '82, Atlantic City Convention Hall, Atlantic City, NJ. For details on this conference and exhibition, contact the Interface Group, 160 Speen St., POB 927, Framingham, MA 01701, (800) 225-4620; in Massachusetts, (617) 879-4502.

June 28-30
National Educational Computing Conference (NECC-82), Radisson-Muehlebach Hotel, Kansas City, MO. This conference features papers, sessions, panel discussions, and exhibits of educational computing products. Among the topics to be addressed are "Computer Use in the Physical Sciences," "Computer Education for Teachers," and "Computer Science, Engineering, and Information Systems Education." For more information, contact E. Michael Staman, NECC-82 General Chairman, Computer Services, 305 Jesse Hall, University of Missouri-Columbia, Columbia, MO 65211.

July 1982

July 6-9
Peripheral Array Processors for Signal Processing and Simulation, University of California, Los Angeles, CA. The fee for this course is $795. For further details, contact Marc Rosenberg, University Extension, 6266 Boelter Hall, University of California-Los Angeles, Los Angeles, CA 90024, (213) 825-1047.

July 11-15
The International Manufacturing Systems Conference '82, Convention Center, Buffalo, NY. The conference theme is "The Technology of Productivity." More than 100 experts will conduct seminars on a wide variety of topics. Exhibits, vendor presentations, and plant tours are planned. Contact Roy Combs, International Manufacturing Systems Conference, 186 North Water St., Rochester, NY 14604, (716) 232-3950.

July 11-25
The Twelfth Annual Summer Institute for Media Arts, Endicott College, Beverly, MA. A wide variety of seminars and workshops will be offered, including computer animation, video production, and computer graphics. For more information, contact the Summer Institute for Media Arts, POB 83, Lincoln Center, MA 01773, (617) 259-0068..

July 13-14
Controlling Electromagnetic Interference, Hyatt Hotel at LA Airport, Los Angeles, CA. This seminar is sponsored by *Electronics* magazine, a McGraw-Hill publication, and is designed for electronics industry professionals who must make technical or cost decisions based on an understanding of electromagnetic interference. Topics of discussion include intersystem problems, designing against environmental noise, how to determine the best frequency for a given application, and the structure and use of intrasystem electromagnetic compatibility models. The fee is $595; in-plant programs can be arranged. Contact Ms. Barbara Bancroft, McGraw-Hill Seminar Center, Room 3112, 305 Madison Ave., New York, NY 10017, (212) 687-0243.

July 14-17
Data Dictionaries, Marina City Club, Los Angeles, CA. The fee for this course is $750. For details, contact the Continuing Education Institute, Suite 1000, 10889 Wilshire Blvd., Los Angeles, CA 90024, (213) 824-9545.

July 18-22
The Fourth General Assembly of the World Future Society, Sheraton Washington Hotel, Washington, DC. The conference theme is "Communications and the Future." All areas of the communications field from telecommunications to interpersonal communication will be covered. The impact of new technologies on society will be explored. Contact the World Future Society, 4916 St. Elmo Ave., Bethesda, MD 20014, (301) 656-8274.

July 19-21
Summer Computer Simulation Conference (SCSC), Marriott City Center Hotel, Denver, CO. The SCSC covers all aspects of computer simulation methodology and applications. Technical sessions and presentations on mathematical methods, model design, simulation languages, and validation techniques will be featured. Information is available from Harvey Marks or Philicia Marks, Transaction Technology Inc., 7648 Capistrano Ave., Canoga Park, CA 91304, (213) 346-5376.

July 21-23
The Computer: Extension of the Human Mind, Eugene Hilton Hotel, Eugene, OR. This conference is sponsored by the University of Oregon College of Education. Workshops, speakers, and presentations on the use of computers in education will be held. Topics of interest include preparing teachers to teach with computers, the ethical and social issues associated with computers, and how computers assist learning. The conference fee is $95; students enrolled in the university's summer session can register for $55 and earn a single credit hour. For additional information, contact Judy Ohmer, College of Education, University of Oregon, Eugene, OR 97403, (503) 686-3405.

July 26-30
SIGGRAPH '82: The Ninth Annual Conference on Computer Graphics and Interactive Techniques, Boston, MA. This conference is sponsored by the Association for Computing Machinery's Special Interest Group on Computer Graphics (ACM SIGGRAPH). More than 140 exhibitors will display the latest in computer-graphics hardware, software, and services. A series of courses and technical sessions on a variety of topics, including device-independent graphics software, low-cost graphics, business graphics, solid modeling, and computer-aided design, will be offered. Other features include a multimedia computer-graphics art

show and computer-generated films. For information, contact SIGGRAPH '82, Convention Services Dept., 111 East Wacker Dr., Chicago, IL 60601, (312) 644-6610.

July 27-30
Database Systems: Comparison, Design, Applications, and Trends, Marina Del Rey Hotel, Marina Del Rey, CA. For more information on this course, contact the Continuing Education Institute, Suite 1000, 10889 Wilshire Blvd., Los Angeles, CA 90024, (213) 824-9545.

August 1982

August 15-19
The Second International Computer Engineering Conference and Exhibition, Sheraton Harbor Island Hotel, San Diego, CA. This conference is sponsored by the Computer Engineering Division of the American Society of Mechanical Engineers (ASME). More than 50 exhibitors will display computer-engineering products, information, and services. The conference will feature technical sessions on more than 60 topics ranging from interactive graphics, personal computing by means of programmable calculators, computer-aided design and manufacturing, and robots. For complete details, contact the ASME, 345 East 47th St., New York, NY 10017, (212) 644-7100.

August 16-20
The National Conference on Artificial Intelligence, Carnegie-Mellon University and the University of Pittsburgh, Pittsburgh, PA. Among the topics to be addressed are expert systems, robotics, computational vision, programmable automation, game playing, and knowledge representation. Other features include an exhibition program and a two-day tutorial program providing a nontechnical look at key areas of artificial-intelligence research. Complete conference details are available from the American Association for Artificial Intelligence, 445 Burgess Dr., Menlo Park, CA 94025, (415) 328-3123.

August 17-20
Electromagnetic Compatibility Design and Measurement for Control of Electromagnetic Interference, Toronto, Ontario, Canada. For details on this course, contact Don White Consultants Inc., State Route 625, POB D, Gainesville, VA 22065, (703) 347-0030.

August 24-26
Electromagnetic Compatibility Design of Printed-Circuit Boards and Electronic Modules, Los Angeles, CA. For details on this course, contact Don White Consultants Inc., State Route 625, POB D, Gainesville, VA 22065, (703) 347-0030. ■

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.

Software Received

Apple

Apple Spice, a set of assembly-language routines to supplement Applesoft for the Apple II Plus. Floppy disk, $29.95. Adventure International, 507 East St., POB 3435, Longwood, FL 32750.

Borg, an arcade-type game for the Apple II Plus. Floppy disk, $29.95. Sirius Software Inc., 10364 Rockingham Dr., Sacramento, CA 95827.

Eliminator, an arcade-type game for the Apple II. Floppy disk, $29.95. Adventure International (see address above).

Executive Briefing System, a system to develop and present visual information for the Apple II. Floppy disk, $199. Professional Software Technology, 180 Franklin St., Cambridge, MA 02139.

Foosball, an arcade-type game for the Apple II. Floppy disk, $29.95. Sirius Software Inc. (see address above).

Key Perfect, a program to verify keyboard program entry from a printed listing for the Apple II. Floppy disk, $29.95. Micro-Sparc Inc., POB 325, Lincoln, MA 01773.

P-LISP, a LISP interpreter for the Apple II. Floppy disk, $199.95. Gnosis, 4005 Chestnut St., Philadelphia, PA 19104.

Rubik's Cube Unlocked, solves Rubik's Cube puzzle for the Apple II. Floppy disk, $24.95. Double-Gold Software, 13126 Anza Dr., Saratoga, CA 95070.

Saga #1 Adventureland, an adventure-type game with graphics for the Apple II Plus. Floppy disk, $19.95. Adventure International (see address above).

Track Attack, an arcade-type game for the Apple II. Floppy disk, $29.95. Broderbund Software, 1938 Fourth St., San Rafael, CA 94901.

Twerps, an arcade-type game for the Apple II Plus. Floppy disk, $29.95. Sirius Software Inc. (see address above).

VC-Manager, a Visicalc-file manipulator for the Apple II Plus. Floppy disk, $65. Micro Decision Systems, POB 1392, Pittsburgh, PA 15219.

CP/M

C/80 Version 2.0, a compiler for the C programming language for CP/M (Z80). 8-inch floppy disk, $49.95. The Software Toolworks, 14478 Glorietta Dr., Sherman Oaks, CA 91423.

Microshell 1.1, an operating system with Unix-like features for CP/M (Z80). Floppy disk, $150. New Generation Systems Inc., 2153 Golf Course Dr., Reston, VA 22091.

Catalog, a disk-cataloging system for CP/M (Z80). 8-inch floppy disk, $75. SRX Systems, 2812 Westberry Dr., San Jose, CA 95132.

FloBASIC 1.1, a preprocessor that helps produce structured programs in BASIC for CP/M (Z80). 8-inch floppy disk, $90. Terrasoft, 25 Bryan Rd., Rowayton, CT 06853.

Texas Instruments

Mission Impossible, an adventure-type game for the TI-99/4. Floppy disk, $29.95. Texas Instruments Inc., 13500 North Central Expressway, POB 225012, Dallas, TX 75265.

Strange Odyssey, an adventure-type game for the TI-99/4. Floppy disk, $29.95. Texas Instruments Inc. (see address above).

TI Invaders, an arcade-type game for the TI-99/4. Command module (ROM cartridge), $39.95. Texas Instruments Inc. (see address above).

Voodoo Castle, an adventure-type game for the TI-99/4. Floppy disk, $29.95. Texas Instruments Inc. (see address above).

TRS-80

AW Rats!, an arcade-type game for the TRS-80 Models I and III. Cassette, $14.95. Creative Thaumaturgy, POB 107, Forest Park Branch, Dayton, OH 45405.

Crunch, an arcade-type game for the TRS-80 Models I and III. Cassette, $14.95. Creative Thaumaturgy (see address above).

Earthquake San Francisco 1906, an adventure-type game for the TRS-80 Models I and III. Floppy disk, $20.95. Adventure International, 507 East St., POB 3435, Longwood, FL 32750.

Electric Pencil 2.0, newest version of the word processor for the TRS-80 Models I and III. Floppy disk, $89.95. IJG Inc., 1260 West Foothill Blvd., Upland, CA 91786.

Lion's Head Adventure, an adventure-type game for the TRS-80 Models I and III. Cassette, $14.95. Creative Thaumaturgy (see address above).

Sfinks 3.0, a chess-playing program for the TRS-80 Models I and III. Cassette and floppy disk, $39.95. William A. Fink, POB 5912, Lighthouse Point, FL 33074.

Space Invader, an arcade-type game for the TRS-80 Models I and III. Cassette, $14.95. Creative Thaumaturgy (see address above).

Super Color Writer 1.0, a word processor for the TRS-80 Color Computer. Cassette, $49.95. Nelson Software Systems, POB 19096, Minneapolis, MN 55419.

Trashman, an arcade-type game for the TRS-80 Models I and III. Cassette, $14.95. Creative Thaumaturgy (see address above).

ZX80

ZX80 1K Disassembler, a disassembler and memory test for the 4K-ROM ZX80 and the Microace. Cassette, $9.95. Lamo-Lem Laboratories, POB 2382, La Jolla, CA 92038.

ZX81 1K Disassembler, a disassembler and memory test for the 8K-ROM ZX81 and the Microace. Cassette, $9.95. Lamo-Lem Laboratories (see address above).

Other Computers

AC Circuit Analysis, analyzes complex electronic circuits for transfer function or impedance for the Atari 800. Floppy disk, $39.95. L. W. James and Associates, 1525 East County Road 58, Fort Collins, CO 80524.

Ezlabel, a mailing-list and label-printing program for the IBM Personal Computer. Floppy disk, $39.95. Systemics, 3050 Spring St., West Bloomfield, MI 48033.■

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.

Software Review

Micro-Decision Support System/Finance (DSS/F)

Robert Moskowitz
22200 Tioga Place
Canoga Park, CA 91304

Micro-Decision Support System/Finance (DSS/F) is the first of what may be a new generation of super-software packages: programs with immense capabilities and multiple automatic functions shoehorned into a microcomputer.

Rusty Luhring of Ferox Microsystems Inc. of Arlington, Virginia, wrote DSS/F. Luhring is a computer veteran with professional experience on mainframe systems. Before he began to develop DSS/F, he worked for a prominent time-sharing company where he was responsible for the technical support of large users with complex financial-modeling needs.

He bought an Apple II microcomputer about two and a half years ago and learned Pascal. Overcoming some microcomputer limitations, Luhring created a *very sophisticated* software package that runs more like commercial programs on large computers than just another version of Visicalc.

Operation

In its current version, DSS/F requires the Apple Pascal system, two or three floppy-disk drives, and a dual-purpose hardware key that comes with the package. Once you have the Pascal prompt on screen and the key plugged into the game-paddle socket, you are ready to execute but not yet ready to produce useful results.

DSS/F builds and reports on a financial model from a series of separate files. By convention, the files carry a common root name and various suffixes to indicate their contents. (The disk name needed to call a file can be set up as a default value to save keystrokes.) MODEL.LOG might be the name of a file that defines the rows, columns, labels, and formulas that make up the model. This file tells the computer how to compute and compare

At a Glance

Name
Micro-DSS/Finance

Type
Financial-modeling software

Manufacturer
Ferox Microsystems Inc.
1701 North Ft. Meyer Drive
Suite 611
Arlington, VA 22209
(703) 841-0800

Publisher
Addison-Wesley Publishing Company
Business and Professional Division
Jacob Way
Reading, MA 01867

Price
$1499; extended service policy: $275 a year

Format
5¼-inch floppy disk

Language Used
Pascal

Computer Needed
Apple II with 48K bytes of memory; two or three disk drives; Pascal language system; 80 or 132 column printer

Documentation
100-page introduction and tutorial manual; 200-page reference manual, both wire bound

Audience
Financial managers, executives, and other business people interested in desktop computerized financial modeling or in providing such capabilities to specialists unfamiliar with computer operating procedures

all the values in the model so as to generate valid, meaningful results. You construct this logic file with the DSS/F Editor program, and you must compile it before you can use it the first time. If you make any changes to this file, you must compile the new version before you can rerun your model.

Following the name example above, the file MODEL.DATA contains the raw input data on which the MODEL.LOG file will operate. One way to use the DSS/F system is to enter all your data via the Editor, save it as a regular MODEL.DATA file, then go through the steps to run the model. Unfortunately, this tends to limit your spontaneity and cut down on the interaction between you and the DSS/F model. To minimize this limitation, enter data from the keyboard during the model run. Special *temporary data* commands allow you to change old values in mid-run and very quickly see the modified results. This approach saves a great deal of time and trouble and allows for "sensitivity analysis," or repeated runs of the model with only minor adjustments to find an optimum set of results.

If you run a DSS/F model without any MODEL.DATA file in memory, you would generate a null set of results. But you are then free to use the various commands to enter temporary data, manipulate it, and even save the computed results in a special disk file. DSS/F lets you retrieve and modify these files as easily as the regular MODEL.DATA files. When used in this manner, the system is much more interactive than virtually any time-sharing system.

Additional files that make up a complete model package include a MODEL.REP file that specifies the full-scale reporting format you will use and a MODEL.WS file that contains the derived information needed to print a work sheet. These work sheets are automatically keyed to the rows and columns of the model you are constructing. More on these and other file types later.

So Many Numbers

Each of the files you need is constructed with the DSS/F Editor. The Editor assigns line numbers to the file as you go, but you must key into the line a row number that corresponds to the position of that line of logic or data in the model. The Editor-supplied line numbers are needed for line-oriented editing commands, such as Insert, Delete, Fix, and so forth. You can safely let the computer take care of these. But the computer does not give you much help with the row numbers, and they are the glue that holds the model together and makes it work.

Earlier versions of DSS/F were limited to a matrix size of 1919 data cells, or intersections of rows and columns. Your matrix could be 19 by 100 elements, 5 by 380, and so on. You could fill all available cells quite easily. (But the consolidation features made it possible to combine the results of separate models, and so work around this memory limitation.) The latest update of DSS/F, however, includes a virtual-storage routine that supports up to 32,000 data cells in a single financial model—a vast expansion in capacity.

DSS/F and Market Positioning

DSS/F is an unusual package in several ways. First and most obvious, its $1500 price tag for a single disk of programming is very steep by personal computer standards. Second, and less obvious, it is published by Addison-Wesley Publishing Company. Addison-Wesley is well established as a publisher of business-oriented materials in print. Taking a flyer on Apple II software seems quite a leap for such a company.

The venture makes more sense if you turn the picture around and look at it from the point of view of mainframe time-sharing users. The organizations employing these people may already spend up to $30,000 a year or more for computerized financial modeling. From their perspective, the DSS/F system is dirt cheap, even if you include the cost of the Apple II, disk drives, and the Pascal language system.

From this perspective, DSS/F is highly interactive too; you can get it running and do several iterations of a model in less than an hour right on your desk, whereas with a mainframe-supported modeling system you may need weeks simply to establish a model that works and do the first iteration.

As you look at the DSS/F package in this way, you begin to see the importance of the emphasis on user support, the orientation of the system toward paper-and-pencil preparation for computer runs, and the capabilities for automated operation by novices. All of these are marked similarities to, or advantages over, traditional time-sharing systems.

Program author Rusty Luhring readily admits much of this. "It is not as interactive as Visicalc," he recently confided, "but it is a whole lot more interactive than the mainframe systems our customers are used to. And while it does require a measure of familiarity with computers and programming to operate, it 'thinks' much more like a financial manager does than most of the time-sharing systems I have worked with."

All this adds up to a new critter in the Apple barnyard. If DSS/F proves itself over the long term—and as of now there is no reason to believe it won't—it may signal the approach of a new wave of software/hardware super-systems that vastly increase the basic Apple II's capabilities and, at the same time, command a vastly increased price.

In operation, DSS/F is very much oriented to row and column numbers. You must keep them straight and be able to refer to them accurately if you want to get anywhere with your model. You can enter the rows of data in any order you wish: the computer builds the same model regardless. As long as the logic specified and the data for it to use carry the correct row numbers, the results will be what you want.

One initially confusing feature is the convention that says all data values must be entered as decimal numbers (1.0, 2.3, 1000000.0, etc.), while any integers (1, 2, 3, etc.) are automatically interpreted as row numbers. (I wish that "R" could be used to specify row numbers, so I wouldn't have to reprogram my brain to match the computer's numerical understanding.)

Another confusing element is the sheer volume of similar numbers: row numbers, line numbers, coded instruction numbers, disk-drive numbers, and data values can blur together and leave room for an embarrassing sequence of silly mistakes. For example, if you insert a value where you need a code number, or a row number where you need a line number or a value, the model will twist itself out of shape, confounding your results but not always flashing an error message.

You can juggle all these numbers successfully in your head only for some of the simpler models. Almost as soon as you try to model a real financial situation, such as a home purchase or the break-even analysis on a new product line, you find yourself swamped in digits. You need a pencil and plenty of paper to dig yourself out. I found frequent printouts extremely helpful too. With a printout of the logic in front of me, for example, I could locate much more quickly the line or row number I wanted to access. Without hard copies of your files, you'll spend a lot of time listing groups of logic or data statements on the screen and trying to remember long series of numbers to key in somewhere else.

Start with the Logic

To start a new model under DSS/F, you must construct a MODEL.LOG file that defines and structures the model. You have no model, and you cannot see any calculated results until you have the correct logic compiled (which may cause up to a five-minute delay each time you do it) and operating on temporary data (or a bona fide MODEL.DATA file). This means that in practice, DSS/F is too slow and cumbersome for simple models and spontaneous "what if" games. It's like outfitting yourself for a weekend in the wilderness—you don't go to all that trouble every time you want to take a walk in the park.

In fact, a quick way to give yourself a headache is to approach a financial-modeling problem by trying to give DSS/F some figures, manipulate them, give it some more data, change a few values, manipulate them slightly differently, and progress in this manner until you have an adequate working model. You cannot easily feel your way along. DSS/F requires more discipline, planning, and preparation. It trades off some simplicity of operation and interactiveness for sophistication and flexibility on the high-end applications.

To use DSS/F properly, you will want to do a lot of paper-and-pencil work before you reach for the keyboard. As with the time-sharing systems you may be familiar with, you must have a firm grasp of what you are doing and where you are in the modeling process in order to make good use of your microcomputer's vast new capabilities.

But once you have a plan for the model you want to construct or once you have a basic financial model debugged and operating, it is very simple with DSS/F to get the model running and test a series of different values.

Real Power

The real power of DSS/F lies in its ability to handle complexity and in its graphics and reporting capabilities. Here is a brief rundown on some of the features that make the DSS/F system flexible, powerful, and useful for large-scale modeling applications.

Enhancements

Ferox Microsystems plans to announce several enhancements to DSS/F soon. Some of these will eliminate problem areas identified in this review. Enhancements will include:

- *a menu-creation capability that will allow users with no computer knowledge to access the full power of DSS/F by simply selecting from a customized menu (no commands or file names required)*
- *the ability to refer to rows by variable names as well as row numbers, making it easier to create and modify logic files and avoid confusion between row and column numbers*
- *"goal seeking" or "backward iteration" will allow the user to reverse the calculation, entering a desired outcome (say, a particular target profit) and DSS/F will calculate the input values required to create that outcome*

Ferox also plans to announce database-manager, statistical, and communications packages, along with a pen-plotter graphics package—all with DSS/F interfaces. All Ferox software runs on the Apple II, Apple III, TRS-80 Model II, and IBM Personal Computer.

Automated work sheets: Once you have the logic file debugged and compiled, you can use the Report function to scan the logic and generate a MODEL.WS file. Printing this file generates a neatly formatted data-collection work sheet. The work sheet emerges from the printer with titles, labels, and appropriate spaces for all the data needed by the logic. If your model uses the built-in Loan, Depreciation, or Tax-Loss Carry-Forward functions, the computer even adds appropriate prompts for needed data to the work sheet without being *asked!*

In practice, you can generate these work sheets for others in your company to fill in, others who may have no understanding of computer modeling and no idea that a computer will later crunch their numbers. This feature saves you time, can increase the accuracy of data used, and even makes keying in the data easier because the work sheet is set up and labeled to fit the MODEL.DATA file structure your model needs.

JOB files: These are like Apple II Exec files. They offer a way to preprogram control of the computer and have it step itself through repetitive or complicated processing sequences. The JOB files are created in the Editor mode and saved under the MODEL.JOB name convention before the JOB mode is entered.

To run the computer in this mode, at the Command prompt, you enter JOB. The computer asks for the file containing the commands. When you give the proper file name, the computer goes off and does its business without you. In the JOB mode, DSS/F is fully capable of loading files, processing data, and printing the results while you do something else. You may appreciate this feature if you want to automate a frequent sequence of modeling commands so you can start the computer, leave the room, and pick up the finished printout later.

GEN files: This type of file controls the computer to prompt for data, insert that data where needed in the model being run, and generate customized reports as needed. GEN files are extremely valuable in conjunction with the data-gathering work sheets and the JOB files if you want to set up the system to give novices access to DSS/F's most advanced modeling capabilities without giving them the extensive training and computer-familiarization experiences they might need to work the system on their own.

While it takes a lot of work, you can use the GEN system to create a totally user-friendly self-controlled financial-modeling system. GEN files contain commands, prompt lines, and up to 20 variables. Available GEN commands include Ask (for input), Get (a file), Write (a file), Job (execute a JOB file), When (test for a condition), and Add and Subtract.

Using the GEN mode and its When commands, for example, you can cause DSS/F to display a menu of numbered choices on the screen, accept keyboard input in response, and then follow a complicated procedure that prompts for financial data from the work sheet, processes it, and produces a printed Report—all automatically. In addition, you can set up other GEN files to prompt the user for specific data to be manipulated within a model as it runs.

Consolidating: A set of commands within the DSS/F system allows you to extract portions of data sets and add them to or subtract them from other portions of other data sets. From several sets of data, you can extract a single row (line item), a single column (time period), or multiple rows and columns. What's more, you can engage a previously created GEN file that prompts for specifications and does the consolidation for you. This makes monthly reporting of sales by product, for example, or projected profit by division a very simple matter. You can create separate models for each of the basic subdivisions within your organization, and then consolidate performance or projections as needed. With the updated virtual-memory capacity, you can build one giant model and simply extract the portions of it you want for any specific report.

While it may take some time and planning to do this consolidation or extraction the first time, you can put the required commands into GEN or JOB files and execute the sequence again later with only a few keystrokes. By putting in the proper on-screen prompts, you can arrange DSS/F to do even the most complicated work for the most naive user.

Built-in functions: DSS/F has a large repertoire of preprogrammed functions it can execute on cue. Briefly, for a given cash-flow stream: NPV computes the net present value, MULTINPV does this for several discount rates, NPVPERPET does it as if the stream were perpetual, IRR gives the internal rate of return for the stream, and PAYBACK computes the number of periods needed to recover the initial investment.

DEPR calculates the depreciation on a given investment item according to five parameters you provide in code, including life, depreciation method, residual value, half- or full-first-year depreciation, and optimal year switch-over options.

Various LOAN functions let DSS/F automatically calculate interest, principal, remaining balance, and periodic payment for a loan according to four parameters you provide in code, including interest rate, number of payments, and starting month.

Tax Loss Carry Forward automatically carries forward into each year of your model any losses applicable from prior years.

A LOOKUP function allows you to specify a table, such as a tax table, and then refer to it in your modeling computations. You set up a table by putting values in columns 1 and 2 which define an interval for each row. Then in another row you list the rows that make up the table.

The LOOKUP function will go to the table, find the appropriate interval into which a search value fits, and then pull out whatever result value is found in the requested column of that row. For example "4 LOOKUP 8 for 10" will do the following: take the value in row 4 (column by column), look it up in the table specified in row 8, find the proper row of that table, and pull out the value in column 10 of that row. The result will be returned, column by column, to the row where the LOOKUP command was placed.

A variety of logical operators and LOOP functions allow more sophisticated manipulation of specific data. If some formulas contain circular references, you can cause DSS/F to solve the model repeatedly until it finds the answer to these "simultaneous equations."

Very Fancy Reporting

While DSS/F may have good points and bad points relative to other microcomputer financial-modeling programs, it is clearly on top when it comes to reporting.

Specific formatting commands tell the computer what values to print, in what order, and where on the page. The computer easily handles pagination, form length, brackets for negative numbers, decimal conventions, and other niceties, as well as providing extensive options for titles and headings, columns, underlining, mixing text and data, and more. It even has a special command to turn the matrix sideways, converting rows to columns and columns to rows.

DSS/F can also be set up to prompt for information as it prints and then to include the keyboard response in subsequent printing.

Specifications for formal reporting must be established using the Editor and saved in a special MODEL.REP file. This can take time. To get a quick response, you can obtain results without a MODEL.REP file. You simply specify the rows and columns you want to see, and DSS/F displays them on the screen (the QD command) or the printer (the PRINT command).

Another output mode is DATAVIEW. This subsystem of DSS/F actually processes data and logic together in real time and displays the results. But it is an interactive mode, and allows you to give various commands to cause selected rows and columns of calculated results to appear. In this mode, the TD command allows you to enter temporary data from the keyboard and have it processed without constructing a MODEL.DATA file and without interrupting the model run.

If you like a set of results, you can save the calculated results to the disk for later retrieval. In the DATAVIEW mode, DSS/F accepts many disk-access, data-entry, and data-manipulation commands.

One nice feature is the ability to set up incremental changes in values, say a 10 percent increase, that is handled automatically by the computer. This saves keystrokes because the computer will accept an initial value and a change factor and use them to fill in an entire series of data values.

Graphics

Once you have your calculated results, DSS/F offers extensive graphics options for displaying them. By ending the modeling session and running the DSS graphics program, you can turn data files or the data currently in memory into pie charts, bar charts, or line graphs quite easily. The computer will calculate the ranges automatically or accept your input and automatically print monthly labels. Color graphics are also no problem.

As with DSS/F reports, its graphs give great freedom for titling, labeling, and highlighting various parts of the finished graphic. You can use a previously saved graph-specification file or wing it as you go. The system provides for such capabilities as stacking up to eight sets of values into a single bar chart.

The hardware key in your game-paddle socket resembles and functions as a slide-projector remote control. It can be used to call up a series of previously constructed graphic images onto the monitor screen, almost exactly as if they were actual slides. It's uncanny to see this feature operate, and it's potentially useful for cutting the time and trouble of actually preparing slides from computer graphics output. Once you change the disk name to TRAY and save your previously prepared graphics images as SLIDE1, SLIDE2. . .SLIDE17, the rest is as easy as pushing a button.

Error Handling

DSS/F's error messages, like all its command prompts, are in English (that is to say, they avoid the common problem of being vague or cryptic). I found the error-trapping and error-handling routines quite good and very friendly. For example, illegal commands are met with the response: "Don't recognize that one. Try again." DSS/F does have some confusing elements not totally accounted for. If you try to run a GEN file with the wrong command, for example, the system responds with a lot of garbage. This can happen more often than you think, because it is very difficult for a person to keep accurate track of all the files involved in a DSS/F model package.

Similarly, it was very common for me to confuse line numbers and row numbers. In both editing the files and running the models, I got confusing and wrong results. And I got unwanted results when I failed to include the needed decimal point in a data value or included one in a row number (where it is never needed). I suppose that experience with the system would eliminate many of these human errors, but these quirks make learning the system more difficult than it should be.

Documentation

I found the 300 or so pages of instructions, reference materials, tutorials, and miscellaneous command lists an extremely valuable and accurate package. Other than a few typographical errors, the package is well written, accurate, and informative.

More to the point, Luhring and his *associates* are very strong on user support. Satisfied users of the package say that Luhring has nursed them through both silly and complicated problems without a murmur of discontent or any effort to point the finger of blame. For the price of this software, which places it in a different market position from most software for the Apple II, you would expect such treatment. It's good that the user can feel confident of getting it.

Conclusions

- DSS/F is a sophisticated and comprehensive financial-management tool that can be a valuable aid to people who have a frequent need for complicated financial planning, modeling, or investment comparisons. All who used it expressed admiration for its sophistication and flexibility.
- Its graphics capabilities are excellent; it handles much of the work automatically and turns data files into visuals very efficiently.
- DSS/F is capable of automatic operation, on-screen prompting, and real-time presentation of its results in both numeric and graphics form. This makes it a flexible tool for processing as well as displaying financial-modeling data.
- The program does not live up to all the claims Addison-Wesley makes for it, though. Contrary to what Addison-Wesley says, the program requires the user to be quite familiar with standard computer operations and procedures and to think in computer—not only financial—terms.
- DSS/F trades quicker familiarization, speedier modeling, and a greater degree of user interaction for enhanced reporting, graphics, calculating, and automated capabilities. It does not compete with cheaper, simpler, and easier modeling programs. Instead, it adds a new high end to the existing levels of Apple II computer capabilities.
- For most financial-planning situations suitable for a microcomputer, using DSS/F is something like using an elephant gun to kill a rabbit. It will do the job, but with a measure of overkill. In practice, the hefty price tag will probably limit the number of small-computer users who will turn to DSS/F. For those who can afford it, though, DSS/F is certainly a very powerful financial-modeling tool. ■

Conditionals in LISP

Use the COND primitive as a decision-making function.

M.S. Howard
83½ Partition St.
Saugerties, NY 12477

LISP is a programming language invented to implement list processing, which is a suitably vague term that denotes all the useful things you can do that involve building lists of objects and other lists, and taking them apart. For example, useful things include translating a high-level language into machine-executable code, bookkeeping, and algebra.

The most useful aspect of a programming language is that it allows programs to be written that mimic problems and situations in the real world. This requires that a program be able to perform actions (make decisions) which are conditioned on the current state of the world (the environment and current data). The ability to make decisions is accomplished in most languages, such as FORTRAN and Pascal, by using the IF statement. Special classes of conditional action are built in to support iteration, with termination depending on a maximum number of counts (DO loops, FOR . . . NEXT loops, etc.) or on some logical predicate's operation on the current environment and data (REPEAT . . . UNTIL . . . , etc). LISP achieves all this using the COND primitive. This article discusses the application of this primitive to emulate the less general constructs of other languages. This is done to explain the syntax and to demonstrate the generality of the COND primitive. (For an overview of the LISP language see the August 1979 BYTE.)

Syntax of COND

It's necessary to know a little about LISP in order to discuss the syntax of COND. LISP is a language that essentially takes a function in a Polish notation form and evaluates it. The general syntax is:

```
(function arg 1 . . . arg N)
```

Please note that I haven't specified anything about the nature of the function, how it is defined, what the arguments are, how many there may be, or even if N must be a known fixed number. LISP doesn't need that information. Basically, you can have almost any type of function that you can define on any type of data structure that you can represent by using tree structures of objects and numbers. The arguments must be definable, e.g., objects with names, numbers, or some function applied to some arguments. If an argument is in a functional form, the system will evaluate it, etc. (If this sounds interesting, read a book on LISP, then go find a computer and play with it for a while.) The language system usually knows an initial set of functions which you don't have to build yourself. These are called primitives.

COND, a LISP primitive, takes a variable number of arguments. The arguments are of the form:

```
(predicate e1 . . . eN)
```

The predicate is a legal expression which is evaluated. If its value is not NIL (a special LISP list which is analogous

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to 0 or the empty set), then each of the expressions e1 through eN is evaluated. The value of the entire COND expression is taken as the value of the last expression evaluated, i.e., the value of eN. In other words, COND is about as general a CASE statement as has been invented.

Simulations

Let's see how COND corresponds to the more common types of conditionals. First we will try to simulate the IF . . . THEN . . . ELSE . . . statement:

```
(COND
  ((predicate of the IF) (the THEN clause))
  ( T [this is not NIL] (the ELSE clause)))
```

The first predicate is the only one we care about, so the second predicate is designed to make sure that the ELSE clause is performed when the IF clause is false. So far, COND appears to have no advantage over IF . . . THEN . . . ELSE . . . , but this is not the case (COND is more general).

Now let's try the CASE OF var DO . . . statement:

```
(COND
  ((EQUAL var case1) e11 . . . e1N)
  ((EQUAL var case2) e21 . . . e2N)
                  .
                  .
                  .
  ((EQUAL var caseM) eM1 . . . eMN))
```

Here COND signals the evaluator to test if var is EQUAL to case1, case2, etc., and to do the appropriate things under those conditions.

More Syntax

To perform other conditionals mentioned at the beginning of this article we need to use recursion. Most programmers consider recursion a nasty word because it is not structured. The fact is that recursive structures, which have been around for a long time, are not all that hard to deal with. Everyone who has taken high school algebra is familiar with proof by induction. This is a fundamental recursive technique and pervades mathematics. The principal problem with recursive programs up to now has been the need for a lot of memory and the slow speed of execution. The memory-size problem was caused by the expense of high-speed memory and the fear that if the program isn't bound by the memory requirements at compile time, it may not fit in the machine. The fact is that high-speed memory is getting cheaper than birdseed, and very few legitimate problems ever really eat up the whole machine.

The second problem is execution speed. I am on shaky ground here, but I am told that the LISP at MIT does number crunching (which LISP is not supposed to do

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well) as speedily as the DEC FORTRAN compiler (using the same computer) working on similar (or maybe the same) problems. This doesn't mean that LISP is necessarily great for number crunching, but it does mean that an interpreted language which encourages recursive programming at every turn need not be all that slow.

Recursion

Now that I have tackled a few prejudices, let's examine what recursion is. Basically, recursive programming is a means of setting down a procedure for writing a program at execution time, as opposed to iteration or standard programming, which is writing a program at compile time. Does this mean that we are writing *self-modifying code*? Not at all. In fact, we are avoiding any nontemporary modification of the state of the computer. The code which we write is not modified. It allows the language interpreter to construct a sequence of routine calls which will solve a given problem at execution time. It just so happens that the sequence of routine calls is problem-dependent and so varies from execution to execution. The state of the system *after* the program has been executed need not be different from what it was prior to execution, and none of the original instructions need be modified. How many times have you messed up a program by modifying a globally defined variable down in some BASIC or Pascal subroutine, and not known what happened when your program blew up? Recursive programming exterminates a lot of those types of bugs before they hatch.

Now that we have recursion, we need to be able to establish function definitions. A language must allow the programmer to associate a name with a function and so invoke a desired function at will. The mechanism used by LISP is the primitive LAMBDA. The syntax of LAMBDA is:

(LAMBDA list-of-variables things-to-do)

The list-of-variables is a LISP-type list of the dummy variables which are used in the function definition. For example, these are the variables you normally see in algebra when you write:

$$f(x,y,z)$$

The things-to-do are the instructions for applying the function. In order to use the function you usually need to name it. This is done in a variety of ways, depending on the particular LISP system you are working on. The University of Wisconsin allows two forms:

```
(SETQ name (LAMBDA etc.))
(CSETQ name (LAMBDA etc.))
```

The difference between the two functions has to do with the way the interpeter retrieves information from memory, and as such is beyond the scope of this article. Just remember that it is possible to name a function.

Recursion in Use

Now that recursion is out of the way, let's simulate a WHILE . . . DO . . . statement:

```
(SETQ f
  (LAMBDA args
    (COND
      ((WHILE clause) things-to-do (f modified-args))
      (T termination-conditions))))
```

This function works by first checking the WHILE clause to see if it is time to quit. If it is, the function does whatever is necessary upon termination time. If it is not time to quit, the function continues, then calls itself to check the WHILE clause, etc.

Now let's simulate a REPEAT . . . UNTIL . . . statement:

```
(SETQ f
  (LAMBDA args
    tasks-to-be-REPEATed
    (COND
      ((termination (i.e. The UNTIL) clause)
      termination-things)
      (T (f modified-args)))))
```

This listing is similar to the WHILE . . . DO . . . statement above. This is because the two forms are essentially the same. The only difference is when the termination clause is tested. The WHILE . . . DO . . . and REPEAT . . . UNTIL . . . forms do not allow for combined forms such as:

```
(SETQ f
  (LAMBDA args
  things-to-be-repeated upon every application
  (COND
    ((termination clause) termination things)
    (T things-to-do if termination clause is false
    (f modified-args)))))
```

This is a simple combination of the two forms.

Conclusion

The usual application of COND in a LISP program is a combination of all the above forms. This is tough on beginning LISP programmers, principally because they generally come from restricted programming environments. They attempt to jam LISP constructs into forms they are familiar with. This doesn't work, because LISP primitives are usually either more general than anything they have (e.g., COND) or more primitive than what they are familiar with (e.g., LAMBDA). They usually don't have much trouble with SETQ because this equates to ':=' or whatever assignment primitive their languages use. But they have an awful time with SET. This feature of LISP, which always associates both a value and a label with an object, opens up all sorts of interesting areas, such as the difference between a function which returns a value and one which has "side effects."■

Programming Quickie

Listing the Disk Directory in CP/M-based Pascal

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You'll often want to obtain a listing of the disk-file directory while operating directly from within an application program. It saves time and simplifies operation.

Because not all CP/M-based languages offer a built-in directory-search-and-list function, you have to create your own. The "getdir" program described here (see listing 1) is a directory-search-and-list program written in Pascal/MT. It will run alone, or you can modify it to run as a subroutine in a host program. Its output is much the same as that of the DIR command in CP/M. Identical results can be obtained in PL/I-80, FORTRAN, and CBASIC by using the algorithms of "getdir" to write assembly-language equivalents where needed. Descriptions of the Search First and Search Next function calls to the CP/M operating system are described in the *CP/M 2.0 and 2.2 Interface Guide*.

The core routine of "getdir" is procedure "gdir". Through procedure "search" it calls CP/M to obtain a directory locator code, which points to the file name most recently placed in the input buffer. "Search" uses CP/M Search First (17) and Search Next (18) functions, which are placed in register C. Register DE holds the pointer to a 12-byte FCB (file control block). This FCB is represented as "title", an array indexed from 0 to 11. Byte 0 in the array indicates the disk number, converted after user input from an ASCII "a" or "b" to a binary 1 or 2. The next eight positions are the file name, followed by the three positions of the extension. They are filled here with question marks to indicate to CP/M that any name found is to be listed.

When "search" returns the directory code, it is multiplied by 32 and added to hexadecimal address 80 (128 decimal), the base of CP/M's file I/O (input/output) buffer. The result, assigned to "dirptr", is the address immediately preceding the 11-character string that will hold a valid file name from the directory. Now that you have control of the string, you can print it, transfer it to storage for later use, or remove names that you don't need displayed.

Procedure "printname" moves the newly found FCB at "dirptr" to a working string called "prntitle", where it is converted to readable form with spacing and colons. The variable "nmctr" limits the output of each line to four names so that the directory will be correctly displayed on a 64-column screen (see listing 2 on page 501).

Procedure "list", which calls "gdir", performs several vital functions. It is kept separate from "gdir" because you may want to modify one or more of its functions. "List" asks you which disk unit is to be searched and resets the CP/M system in preparation for listing the directory. Reset is mandatory; otherwise CP/M gets lost and throws garbage into the I/O buffer.

In Pascal/MT, an extension to the standard language allows an external procedure, with the absolute address of "bdos", to perform the reset function. If your compiler does not offer such an extension, "setdisk" may be replaced with the following assembly-language equivalent:

```
mvi     c,resetf     ;resetf equ 13
call    bdos         ;entry point at 0005
```

In CBASIC this function is performed by the built-in statement INITIALIZE, which must be used before calling an assembly-language version of "getdir".

The third function of "list" is the assignment of a string to the variable "title". This determines whether all names or only specific names are returned in register A by the Search First and Search Next calls. If "title" is chr(0) + "???????????", then everything on the default disk would be returned. If "title" is chr(2) + "????????DAT", then only those file names on disk B with the extension DAT would be returned. ■

Listing 1: *The "getdir" program, written in Pascal/MT, version 3.2, will search a CP/M disk and provide you with a listing of the disk directory from within an application program.*

```
program getdir;

(*      Directory Search and Print...       *)
(*      By Daniel S. Hunt, April 3, 1981    *)
(*      Pascal/MT 3.2, CP/M 2.2,  Sol-20    *)

type filenametype = packed array[0..11] of char;

procedure external[5] setdisk(func : integer);


function ucase(inchar : char) : char;
begin {convert lower to upper case}
   if (inchar >= 'a') and (inchar <= 'z') then
      ucase := chr( ord(inchar) & $5f)
   else ucase := inchar;
end;


procedure gdir(var title : filenametype);
const
    eodir = 255; {CP/M end of directory}
var
    prntitle : filenametype;
    ch : char;
    i : integer;
    dirptr : integer;
    func : integer;
    nmctr : integer;
    dircode   : integer;

    procedure search(var title:filenametype;
                     var dircode : integer;
                     func : integer);
    const
        bdos = $0005;
    var
        fcb  : integer;
        rega : integer;
    begin
        fcb := $5c;                {fcb address}
        move(title,fcb^,12);       {12 = fcb length}
        inline(
```

Listing 1 continued:

```
              "lhld / fcb /
              "xchg /             {fcb address to regs.DE}
              "lhld / func /
              "mov     c,l /      {search function to C}
              "call  / bdos /     {returns directory code}
              "mov  l,a /
              "mvi h / $00 /
              "shld / rega);
              dircode := rega;    {reg.A passed back via dircode}
    end;{search}


    procedure printname;
    begin
        move(dirptr^,prntitle,12);
        if nmctr = 1 then {only at start of line do we...}
            begin         {...precede name with unit name}
                {by translating back to uppercase letter.}
                ch := title[0];
                ch := chr(ord(ch) + ord('@'));
                write(ch);
            end;
        write(' : ');
        for i := 1 to 8 do  {chars[1..8] of filename}
            write(prntitle[i]);
        write(' ');
        for i := 9 to 11 do {3-character extension}
            write(prntitle[i]);
        if nmctr = 4 then
            begin {on end of line, return, reset counter}
                writeln;
                nmctr := 0;
            end
    end; {printname}

begin  {gdir}
    nmctr := 0;
    func := 17;  {cpm search first}
    search(title,dircode,func);
    func := 18;  {cpm search next}
    while dircode <> eodir do
    begin
        nmctr := nmctr + 1;
        {calculate index, print and search for next}
```

Listing 1 continued on page 500

Listing 1 continued:

```
        dirptr := 128 + (dircode * 32);
        printname;
        search(title,dircode,func);
    end
end; {gdir}

procedure list;
var
    title : filenametype;
    ch    : char;
    func  : integer;
begin
    title := '????????????';  {bytes 1..11 all wild cards}
    write('LIST DISK DIRECTORY: Unit A or B? ');
    read(ch);
    {translate disk name to binary}
    ch := ucase(ch);
    ch := chr(ord(ch) - ord('@'));

    title[0] := ch;  {byte 0 is disk unit number}

    {re-set cp/m, default dma buffer to 80 hex}
    func := 13;     {mvi c,resetf}
    setdisk(func); {call bdos}
    writeln;
    gdir(title);
    writeln;
end;

begin (*main*)
    repeat list until false;
end.
```

Listing 2: *Sample output from "getdir" showing both the A and B disk directories.*

```
getdir
LIST DISK DIRECTORY: Unit A or B? a
A : STAT     COM : EDIT     COM : SYSF     COM : PIP      COM
A : AUTO     COM : SETBIT   COM : GNTOKEN  LIB : DRAW     SRC
A : PAS      COM : PROMOLIB SRC : PASCAL/B RTP : P1ERRORS TXT
A : P2ERRORS TXT : GDIR     DOC : GDIR     BAK : GDIR     LIB
A : CRTLONG  LIB : TRAILMIN LIB : P2/BCD   OVL : SOLIO    LIB
A : VIEW     COM : LTEST    SRC : LTEST    COM : LTEST    BAK
A : ITEST    BAK : ITEST    COM : ITEST    SRC : TTYLONG  BAK
A : TTYLONG  LIB : GETDIR   SRC : GETDIR   BAK : GETDIR   COM

LIST DISK DIRECTORY: Unit A or B? b
B : QUMESTAR COM : PIP      COM : STAT     COM : RND/IO   SRC
B : WRITEHEX LIB : P2/FLT   OVL : STDLIB   SRC : GNB      LIB
B : PASCAL/F RTP : FLTCOMP  COM : WNB      LIB : NEWDB    SRC
B : GNR      LIB : CATALOGX SRC : PARSTEXT SRC : SID      COM
B : CRTLONG  LIB : GDIR     LIB : P1ERRORS TXT : DCONV    LIB
B : GNSTR    LIB : DUMPSUBS SRC : SETBIT   SRC : DISKMAP  LIB
B : DEMOIO   SRC : P2ERRORS TXT : PARSFRAC LIB : PARSERS  SRC
B : SCONV    LIB : CLONGTRM LIB : PARSEIO  LIB : WSMSGS   COM
B : SOLIO    LIB : WNSTR    LIB : TTYLTRM  LIB : RDCONSF  LIB
B : UTILMISC LIB : CALC     SRC : PRINTAT  SRC : FNAMPARS LIB
B : CHAROPS  LIB : HEXC     LIB : TTYLONG  LIB : READHEX  LIB
B : TTEST    SRC : SETMEM   LIB : READSTR  LIB : GETSYM   LIB

LIST DISK DIRECTORY: Unit A or B?
```

What's New?

PUBLICATIONS

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Your Fortune in the Microcomputer Business, a two-volume series, serves as a complete reference guide for anyone wanting to break into the microcomputer industry. The first volume surveys the market, shows you how to select the right product or service and get necessary capital, and details the steps to follow when establishing a business. The second volume deals with the problems and decisions that must be faced when business starts rolling.

Each volume of Your Fortune in the Microcomputer Business costs $20. For further details, contact Wildfire Publishing Co., 326 Toro Canyon Rd., Carpinteria, CA 93013, (805) 684-1489.

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TRS-80 Interfacing Guide

The TRS-80 M1/M3 Interfacing Guide describes the APIO-80 all-purpose I/O interface for the TRS-80 Models I and III. The guide offers information on how to control AC circuits with relays or triacs; how to control moisture, light, and voltage sensors; and how to control analog I/O. Also described are basic software techniques such as controlling individual bits and creating programmable waveforms. Additionally, the guide has information on interfacing a TRS-80 to a telephone for remote applications. The guide is available for $2.50 from Syntex Electronic Innovations, Department 86, POB 4034, Lancaster, PA 17604.

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Computer Science Catalog

The 1982 edition of the North-Holland Computer Science Catalog has information on 130 books and 25 journals covering all branches of information processing. The catalog is available free of charge from Han van Eybergen, North-Holland Publishing Co., POB 103, 1000 AC, Amsterdam, the Netherlands.

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Wordstar 3.0 Literature

A 16-page brochure that describes the 3.0 Wordstar word-processing program is available from Micropro International. The brochure illustrates the standard operating capabilities of the program and its new features, which include horizontal-scroll and column-move capabilities and easy-to-understand menus. Descriptions of the Spellstar and Mail Merge programs are provided. For your copy, contact Micropro International Corp., Literature Department, 1299 Fourth St., San Rafael, CA 94901, (415) 457-8990.

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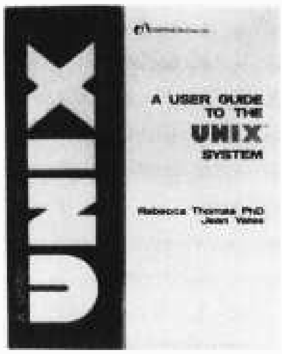

Guide to Unix

A User Guide to the Unix System by Jean Yates and Rebecca Thomas is an introduction to the structure, software, and capabilities of this popular operating system. Written with the beginner in mind, this book explains how to log on to the system, enter the shell, handle files, send mail, and create directories. Other features include an introduction to Unix's sophisticated utility programs and information about Unix system software, related products, university facilities, user groups, and newsletters.

The book is available in paperback for $15.99 from Osborne/McGraw-Hill, 630 Bancroft Way, Berkeley, CA 94710, (415) 548-2805.

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Management by Multiple Objectives

Management by Multiple Objectives (MBMO) is both a procedure and the title of a new book by Sang M. Lee. MBMO is an approach to integrating management systems and modern management technology to achieve many objectives. MBMO addresses a major shortcoming of management by objectives: how to reconcile mutually exclusive objectives to best meet the goals of the entire organization.

Management by Multiple Objectives provides a basic understanding of MBMO concepts and techniques as well as the resourses required to design and carry out an effective MBMO system. It is available for $17.50 from Van Nostrand Reinhold Co., 135 West 50th St., New York, NY 10020, (212) 265-8700.

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Playmasters Mac Oglesby, Len Lindsay, and Dorothy B. Kunkin have designed a collection of computer games and recreations for computer-game enthusiasts of all ages. PET Games and Recreations has games that test your ability to plot winning strategies, that cast you in the role of a detective, and even games that help develop counting and language skills.

In hardcover, PET Games and Recreations costs $14.95. The softcover price is $9.95. For details, contact the Reston Publishing Co., 11480 Sunset Hills Rd., Reston, VA 22090, (800) 336-0338; in Virginia, (703) 437-8900.

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What's New?

Introduction to Microprocessors

From Chips to Systems: An Introduction to Microprocessors, by Rodnay Zaks, is written for owners and users of personal and business computers. Containing more than 320 illustrations, the book explains what a microprocessor is, what it does, and how it performs its tasks.

From Chips to Systems: An Introduction to Microprocessors is available in softcover for $14.95 from Sybex, 2344 Sixth St., Berkeley, CA 94710, (415) 848-8233.

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Programming the Apple

Programming the Apple by John Campbell and Lance Zimmerman contains enough information to keep even the best programmer occupied for a long time, yet beginners can also benefit from it. The book has more than 330 illustrations that help readers understand Apple program development and testing, graphics, and operating systems. A glossary and a bibliography are provided.

Programming the Apple costs $24.95. Contact Mesa Research Inc., Route 1, Box 1456A, Waco, TX 76710, (817) 848-5272.

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Computer Simulation of Cryptography

Computer Simulation of Classical Substitution Cryptographic Systems by Rudolph F. Lauer is packed with BASIC programs that let users simulate virtually any classical substitution cipher system. A number of cryptanalytic programs that assist readers in solving problems are given in each chapter. Other features include information on and a comprehensive list of U.S. cryptographic patents, a treatise on cryptanalysis, background information on various systems, discussions on cryptographic problems, and problems to be solved.

Computer Simulation of Classical Substitution Cryptographic Systems is available in softcover for $24.80 from Aegean Park Press, POB 2837, Laguna Hills, CA 92653, (714) 586-8811.

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SYSTEMS

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The Super/Net, a single-board S-100 computer system, runs under the CP/M or MP/M operating systems. The board consists of a 64K-byte bank-select dynamic RAM (random-access read/write memory), a Z80A processor, a 2K-byte 2716 monitor EPROM (erasable programmable read-only memory), 5¼- and 8-inch floppy-disk controller, two serial and two parallel ports, and a Z80A counter/timer circuit for real-time interrupts.

The Super/Net meets IEEE-696 S-100 bus specifications and has a suggested retail price of $1125. Contact Advanced Micro Digital Corp., Suite E, 7201 Garden Grove Blvd., Garden Grove, CA 92641, (714) 891-4004.

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Multiuser System Supports Work Stations

The 5032 Multishare is a multiuser, multitasking system that can support up to five work stations. The 5032 features a 32-megabyte 8-inch Winchester hard-disk drive, a 6-MHz Z80B processor, and an expanded 128K-byte RAM (random-access read/write memory) that provides 56K bytes per terminal. Additionally, the 5032 has an extended version of the CP/M operating system and the ability to support a serial and a parallel printer simultaneously. Standard software includes Microsoft BASIC, the Scope editor, and ZSM assembler.

Available options include a four-track 15-megabyte cartridge-tape unit for system backup. The basic 5032 Multishare System, comprised of a video console, keyboard, chassis with independent power supply, the Winchester drive, and a floppy-disk drive, costs $13,995. Additional terminals cost $1995 apiece; the backup tape drive costs $3695. Contact Vector Graphic Inc., 500 North Ventu Park Rd., Thousand Oaks, CA 91320, (805) 499-5831.

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Business Computer

The basic Victor 9000 business computer has 128K bytes of memory, internally expandable to 256K or 521K bytes. Standard features of this 16-bit machine include disk-storage capacity of 1.2 megabytes, detachable keyboard with a user-defined function key, a 10-key numeric keypad, and a tilt-and-swivel video monitor with dual-format operation. In the normal format, the monitor can approximate a typewritten page of 80 characters by 25 lines. In the expanded mode, under program control, the character generator can display 132 characters by 50 lines. The screen can simultaneously display high-resolution graphics, bar charts, pie charts, diagrams, and schematics. It's capable of addressing up to 800 horizontal dots by 400 vertical dots.

The Victor 9000 is available for $4995. Contact Victor Business Products, 3900 North Rockwell St., Chicago, IL 60618, (312) 539-8200.

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Eagle Comes with Software

The Eagle II small-business computer is supplied with its own software. Users merely select the suitable software package to use the Eagle for word processing or accounting applications. In the accounting mode, a single entry simultaneously places information into the appropriate accounts: general ledger, accounts receivable and payable, inventory control, payroll, sales or purchase order, and so forth. The Eagle's double-entry accounting system automatically checks for errors.

In the word-processing mode, the Eagle displays information onscreen for editing, rearranging, storage, or output to a printer. Operating instructions can be accessed by a help key.

The Eagle II is CP/M-compatible, and its mass storage is expandable to more than 10 megabytes. It features both a standard typewriter keyboard and a numeric keypad. The Eagle II is available for $4995 from Transnational Computer Corp., 1545 Old Bayshore Highway, Burlingame, CA 94010, (415) 692-7525.

Circle 563 on inquiry card.

6502-based Desktop System

The MTU-130 is a 6502-based desktop computer that can address more than 64K bytes of RAM (random-access read/write memory) without explicit bank-switching commands. The MTU-130 has a 256K-byte address space, 480 by 256 high-resolution graphics, up to 4 megabytes of storage on floppy disk, 80K bytes of RAM (random-access read/write memory), and antipiracy hardware that allows software vendors to protect their work. The system's 96-key keyboard features a full numeric keypad, cursor keys, and 10 programmable function keys. Other features include a one-watt audio amplifier, a 5- by 3-inch speaker, slots for four expansion boards, rear connectors for RS-232C and two parallel I/O ports, and switched AC outlets. The MTU-130's 80-character by 25-line display features a full-screen editor.

System software includes an advanced disk operating system called CODOS, which has Unix-style files, device-independent I/O, and, according to the manufacturer, the ability to locate and load a 32K-byte file in less than 3 seconds. Microsoft BASIC is provided and has been enhanced to allow programs to specify "libraries" of additional commands. Standard libraries include graphics and operating-system interface commands. Also provided is a four-voice music package that uses the system's 8-bit analog-to-digital converter.

The MTU-130 is available from Micro Technology Unlimited, 2806 Hillsborough St., POB 12106, Raleigh, NC 27605, (919) 833-1458.

Circle 564 on inquiry card.

Cromemco Unveils Desktop Computer

Cromemco's System One desktop computer is designed for single- and multiuser applications. The basic System One comes with Cromemco's Z80A-based central processing unit, 64K bytes of RAM (random-access read/write memory), a printer interface, and dual quad-capacity 5¼-inch floppy-disk drives that can provide up to 780K bytes of storage. Standard features include diagnostics that provide a quick test to see that the memory, controller, and disk drives are operating properly. Software support includes the Writemaster word-processing program, the Slidemaster graphics package, and a database-management system. Available software includes Structured BASIC, FORTRAN, COBOL, C, RATFOR, and LISP.

The Model CS-1 System One, with a choice of operatings systems including Cromix, is available from Cromemco dealers for $3995. Contact Cromemco Inc., 280 Bernardo Ave., Mountain View, CA 94043, (415) 964-7400.

Circle 565 on inquiry card.

JBE 1 Single-board Computer

The 6502-based JBE 1 is a single-board microcomputer with room enough for 16K bytes of EPROM (erasable programmable read-only memory), 4K bytes of RAM (random-access read/write memory), eight parallel ports, and a serial port. All address and data lines, power supply, RDY (ready), interrupts, and DMA (direct memory access) are brought off the board to a 50-pin edge connector.

Three JBE 1 versions are available: a fully populated board, a partially populated board, and a bare board. Documentation includes a 6502 programming manual and complete documentation for a 6522

VIA (versatile interface adapter), interfacing with an AD/DA (analog-to-digital/digital-to-analog) converter, solid-state switch, EPROM programmer, and a parallel-input speech synthesizer.

Available options include a monitor and tiny BASIC. The fully populated JBE 1 costs $349.95, the partially populated version is $249.95, and the bare board costs $89.95. The EPROM with Tiny BASIC is available for $19.95; the EPROM with monitor costs $19.95. Information is available from John Bell Engineering Inc., POB 338, Redwood City, CA 94064, (415) 367-1137.

Circle 566 on inquiry card.

New Computer from Hewlett-Packard

The HP-87 microcomputer features an 80-column by 24- or 16-line high-resolution video display with 16K bytes of dedicated RAM (random-access read/write memory). Standard features include 48K bytes of enhanced HP (Hewlett-Packard) BASIC in ROM (read-only memory) and 32K bytes of RAM, expandable to 544K. All RAM is automatically configured into a single block when the HP-87 is switched on. Additionally, all memory can be used for program execution and data storage. Other system highlights include CP/M and HP-85 compatibility and a built-in interface, the HP-IB, which can communicate with a wide variety of Hewlett-Packard peripherals.

Among the options available for the HP-87 are Visicalc Plus, a serial RS-232C interface, a Centronics-type parallel printer, and add-on RAM modules of 32K, 64K, and 128K bytes. Software available for the HP-87 includes Hewlett-Packard CP/M software, Micropro's database management programs, and the Wordstar word-processing system.

The HP-87 is available at local Hewlett-Packard dealers for $2495 to $7995, depending upon optional equipment. For the location of your nearest Hewlett-Packard dealer, call (800) 547-3400. In Alaska, Hawaii, and Oregon, call (503) 758-1010.

Circle 567 on inquiry card.

S-100 Computers

Tecmar's new series of S-100 microcomputers are based on the 16-bit 8086 microprocessor. The Tec-86 includes the 8086 with vectored interrupts; 64K bytes of dynamic RAM (random-access read/write memory) or 32K bytes of static RAM, expandable to 1 megabyte; two serial RS-232C ports; three 8-bit parallel ports; EPROM (erasable programmable read-only memory) boot for the CP/M-86 operating system; double-density floppy-disk controller; dual 8-inch Shugart Associates' floppy-disk drives; and power supplies. The Tec-86W has all these features plus a 31-megabyte Winchester hard-disk drive and 256K bytes of RAM.

Systems software includes CP/M-86, Microsoft BASIC-86, and Pascal/M86. The Tec-86 costs $3990; the Tec-86W costs $9990. For details, contact Tecmar Inc., 23600 Mercantile Rd., Cleveland, OH 44122, (216) 464-7410.

Circle 568 on inquiry card.

SOFTWARE

Unix Features for CP/M

Microshell is a user-friendly interface program that brings the power of the Unix operating system to any 8080-, 8085-, or Z80-based CP/M 2.2 system. Compatibility with CP/M programs is retained, but the user can enter multiple commands on a line, send normal output to a file rather than to the screen, and take input from a file instead of the keyboard. Microshell performs automatic disk-drive searches, eliminating the need for disk-drive prefixes to file names. Other features include direct execution of commands from a file without using the submit facility, user-defined prompt with drive or user number, user-customized search path to accommodate floppy- or hard-disk configurations, and an expanded submit facility. The Unix pipe facility is carried out using temporary files.

Microshell is available on 5¼- or 8-inch disks, including manual, for $150. For further details, contact New Generation Systems Inc., 2153 Golf Course Dr., Reston, VA 22091, (703) 476-9143.

Circle 569 on inquiry card.

Disk Catalog System

Catalog, a master disk-cataloging system for CP/M-based 8080/Z80 computers, builds and maintains a compressed master database that's packed with information pertinent to each file. File displays include file name, file type, file size, and disk numbers with file- and user-entered notes. Among its other features are disk-content displays with the date of last entry and space used, and a quick summary of all disks including disk number and date last entered into database.

Catalog operates on CP/M versions 1.4, 2.0, and 2.2, and requires two disk drives and 24K bytes of memory. Catalog is available for $75, plus $2 shipping and handling, from SRX Systems, 2812 Westberry Dr., San Jose, CA 95132, (408) 926-9411.

Circle 570 on inquiry card.

BASIC Language Extension

BLX (BASIC Language Extension) is a structured programming tool that makes readable BASIC-80 or CBASIC programs possible. BLX provides an assortment of structures for program flow control, consistently formatted listings to highlight program structure, automatic indentation of structures, remark positioning, and subroutine separation. It produces two outputs: a "pure" BASIC file and a formatted listing file.

Designed to be used with 44K-byte CP/M operating systems, BLX costs $95, including documentation. The documentation alone costs $20; the BLX translator with documentation is available for $65. For further details, contact Quelo, 843 Northwest 54th, Seattle, WA 98107, (206) 784-8018.

Circle 571 on inquiry card.

6809 Pascal Compiler

Omegasoft's native-code Pascal compiler runs under the MDOS, XDOS, Flex, DOS69, or OS-9 operating systems. The single-pass compiler rapidly translates Pascal into optimized 6809 assembly-language code. It permits long integers that allow representation of dollar amounts without the speed penalties of double-precision real or BCD (binary-coded decimal) implementations. Full dynamic-variable allocation is provided by means of the NEW, DISPOSE, MARK, and RELEASE procedures. Random-access files are supported. Other features include a symbolic debugger, run-time library with source code, and utilities to assist in creating a chain file for automatically linking a user's program with the run-time library.

The native-code Pascal compiler requires a 48K-byte system. Options include a relocatable assembler and linker. The compiler is supplied with a language reference handbook and a configuration manual detailing operating-system-dependent features. The suggested price is $425. The assembler and linker cost $75. Contact Omegasoft Industrial Products Group, POB 70265, Sunnyvale, CA 94086.

Project Management System

The Visischedule program lets you create onscreen schedules of projects and tasks that incorporate all pertinent data, including costs, manpower, resource leveling, and scheduling constraints. Immediate response is given to your "What if?" schedule changes, complete with effects on subsequent events. Visischedule can chart and print out start and stop dates, slack time, holidays, and deadlines for as many as 160 projects. Visischedule can generate computer reports providing critical-path information, cost estimates, deadlines, and prerequisites of all or some of the project tasks.

Visischedule requires an Apple II or II Plus with a minimum of 48K bytes of memory and two disk drives. It's available for $300 from Visicorp, 2895 Zanker Rd., San Jose, CA 95134, (408) 946-9000.

Circle 572 on inquiry card.

```
Dear Ada,

Having a great time. Wish you were
programming here.

By the way, your billing program has a
bug in it. I think its a type coercion
problem in your new language. Let me
know what you think.
                              Love, C.B.
```

Electric Blackboard

The Electric Blackboard is a multiwindow full-screen text editor that runs on any Z80-based microcomputer running under the CP/M operating system. The Blackboard lets you divide your display screen into vertical and horizontal windows as narrow as one column or as thin as a line. Text is edited directly in each window, and results are seen immediately. Windows can be created or deleted as needed. The Blackboard lets you load, save, erase, move text, replace strings, and perform other functions when you want and in any window, independently of the other windows. Other features include automatic horizontal and vertical scrolling, keystroke saving, large- and wide-file editing, automatic memory management, a picture cursor that lets you set the direction that the cursor will move after a character is typed, the ability to display two or more separate pieces of text, and easy rendering of diagrams, flowcharts, and graphs.

The Electric Blackboard, including a learning guide, a reference manual, and a quick-reference card, costs less than $200 and is available from Santa Cruz Software Services, 1711 Quail Hollow Rd., Ben Lomond, CA 95005, (408) 336-2170.

Circle 573 on inquiry card.

Smart Security Analysis

The SMART (Securities Market Analysis, Reporting, and Transaction) system is designed for institutional money managers and sophisticated investors. SMART gives the Apple II Plus the ability to retrieve, store, graph, and analyze securities and economic data. A portfolio module provides capabilities for maintaining and reporting data and transactions for securities portfolios. SMART lets you automatically access data from one or more remote databases over telephone lines and prepare graphic displays in a variety of formats. Analytic tools include moving averages, exponential smoothing, momentum, trend lines, and user-defined formulas.

SMART, which is available for $1950, requires a 48K-byte Apple II Plus, two disk drives, a micromodem, a monitor, and a printer. For more information, contact Software Resources Inc., Suite 310, 186 Alewife Brook Parkway, Cambridge, MA 02138, (617) 497-5900.

Circle 574 on inquiry card.

SMC BASIC on Fortune 32:16

Fortune System's 32:16 microcomputer is now available with SMC BASIC, a business-oriented interpreter with keyed-access capabilities, dynamic-memory management, and fast execution. SMC BASIC allows the IDOL database-management system and other business-applications software to be run on the 68000-based Fortune 32:16. For further details, contact SMC Systems and Technology Inc., Proprietary Systems Division, POB 6800, Bridgewater, NJ 08807, (201) 685-9000.

Circle 575 on inquiry card.

Farm and Ranch Management Programs

American Small Business Computers' Farm and Ranch Management programs are designed for the Radio Shack TRS-80 Models I, II, and III. Developed at the Oklahoma State University's Agriculture division, program titles include Beef Projection, Feed Lot, Government Program, Feed Formulator, and Pasture Projection. Program prices range from $15 to $100. Contact American Small Business Computers, 118 South Mill St., Pryor, OK 74361, (918) 825-4844.

Circle 576 on inquiry card.

Color Adventures

Your Apple II can be the setting for Scott Adams's series of high-resolution-graphics Adventures. The graphics are compressed and drawn using more than 100 colors. In addition, the programs support the Votrax Type 'N Talk voice synthesizer. Adventureland, the first adventure in the series, is available for $29.95 from Adventure International, Department G, POB 3435, Longwood, FL 32750, (800) 327-7172; in Florida, (305) 862-6917.

Circle 577 on inquiry card.

CP/M Users Compat

Compat, a disk-utility program that provides CP/M users with complete access to IBM System 3740 formatted disks, offers total file-compatibility between CP/M and IBM 3740 disks. With Compat, IBM data can be read into and can be processed by a CP/M system, and vice versa. Additionally, IBM 3740 disks can be created on a CP/M system. Compat costs $99.95 and is available from Starr Computer Systems Inc., 6126 Melissa Ln., Omaha, NE 68152, (402) 571-1722.

Circle 578 on inquiry card.

PERIPHERALS

Portable Terminal with Printer

The Execuport 4120 is a multiprocessor-based portable terminal system with a thermal printer. The 4120 can produce high-resolution characters up to 233 characters per line, complete with fully formed lowercase descenders, at speeds of up to 120 cps (characters per second). Two character fonts are available: 9 by 11, which can print both standard and high-resolution copy at 10 characters per inch, and 5 by 7, which produces a 16¾-characters-per-inch compressed print. System operating modes can be changed through keyboard instructions.

The 4120 is offered with a choice of modems and modem combinations that operate at 300 bps (bits per second) and 1200 bps. Through its RS-232C port, the 4120 can communicate at data rates up to 9600 bps. Provisions are available for as much as 56K-byte RAM (random-access read/write memory). For further details, contact Computer Transceiver Systems Inc., East 66 Midland Ave., POB 15, Paramus, NJ 07652, (201) 261-6800.

Circle 579 on inquiry card.

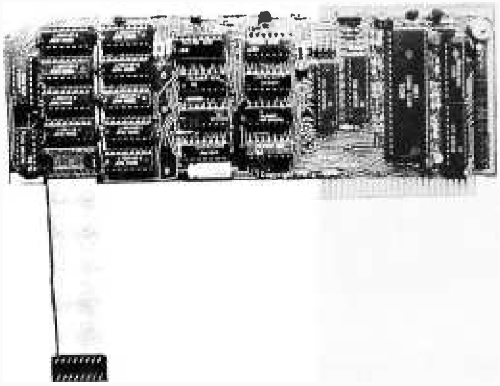
Small-System Network Capability

Radio Shack's Network 3 Controller can link 16 nondisk TRS-80 Model IIIs to a master Model III disk computer. With the Network 3 in command, each work station can simultaneously run a disk-based program while functioning as if it were an independent, disk-equipped unit, complete with disk load and store commands. The Network 3 lets each work station select any program from a menu of programs on the host computer and employ a printer (optional) attached to itself or to the host computer. Print requests to the host computer are automatically queued.

The TRS-80 Network 3 Controller requires a TRS-80 Model III with a minimum of 32K bytes of RAM (random-access read/write memory), one disk drive, and an RS-232C interface for its host. Individual work stations require a TRS-80 Model III with a minimum of 16K bytes of memory, Model III BASIC, and an RS-232C interface. The Network 3 Controller is available for $599 at Radio Shack stores, Computer Centers, and participating dealers.

Circle 580 on inquiry card.

What's New?



Add Versatility to Your Apple

The Synergy-Card is a 16K-byte RAM (random-access read/write memory) card capable of adding a parallel printer port (Centronics standard), a serial RS-232C port, two interval timers, a real-time clock/calendar, and a BSR X-10 interface to an Apple II. It can save up to five Apple slots while reducing power consumption. Serial data rates are software-selectable from 50 to 9600 bits per second.

Options for the Synergy-Card include two programmable-interval timers that allow the Apple to do multiprogramming by producing regular interrupts so that programs can be run on a priority basis. An optional clock/calendar, supplied with batteries, is capable of automatically storing file creation time and date plus displaying day of week, month, year, hour, minute, second, and millisecond. The BSR X-10 interface option lets the Apple control any plug-in electrical device.

The Synergy-Card costs $195, including a user's manual. The options range in price from $20 to $59. Contact Spies Laboratories, POB 336, Lawndale, CA 90260, (213) 644-0056.

Circle 581 on inquiry card.

Logic Analyzer

The Kanel A2-1 logic-analyzer card can analyze TTL-compatible MOS (metal-oxide semiconductor) and TTL circuits. Designed for the Apple II, the card has 32 data input probes and 16 data output probes that are connected to the card by three ribbon cables. Software-supplied displays enter signals as columns of 1s and 0s. Additionally, from one to 16 inputs can be used for a trigger pattern.

The A2-1 is supplied with sample routines in BASIC, Pascal, and assembly language that can help you write custom programs for programmed stimulus-and-response interaction with circuits to be tested. The A2-1 logical analyzer costs $400 and is available from the Kanel Corp., Department A, 1025 Reynolds Rd. B202, Johnson City, NY 13790.

Circle 582 on inquiry card.

Letter-Quality Printers

Southern Systems introduces two letter-quality daisy-wheel printers. The Model 3500 operates at 33 cps (characters per second), and the Model 7700 operates at 55 cps. Both feature parallel or serial interfacing (synchronous or asynchronous), automatic proportional spacing, and ribbon cartridges. The printers' forms-handling options include bidirectional tractor feed, cut-sheet guide with automatic loading, single-bin cut-sheet feeder, and a dual-bin adapter. Word-processing options include proportional-space printing, half-linefeed, negative half-linefeed, automatic bold printing, shadow printing, and underscore.

For complete details on these printers, contact Southern Systems Inc., 2841 Cypress Creek Rd., Fort Lauderdale, FL 33309, (305) 979-1000.

Circle 583 on inquiry card.

Family of Printers

The IPS-5000-C is the featured member of Dataroyal's new line of intelligent printers. The 5000-C is a 165-character-per-second impact dot-matrix printer with increased programmable memory, graphics abilities, international character sets (optional), and a variety of user-selectable print styles. Standard features include a 500-character FIFO (first-in/first-out) buffer, X-ON/X-OFF protocols, paper and forms-handling widths from 3 to 15 inches, and the ability to print originals plus five copies. The 5000-C has both a parallel Centronics-type interface and an RS-232C interface, which operates at data rates from 110 to 9600 bits per second. Mean time between failures is 1500 hours at 100-percent duty cycle and paper density.

Members of the IPS-5000 family range in price from $1100 to $1695; quantity discounts are available. For further details, contact Dataroyal Inc., 235 Main Dunstable Rd., Nashua, NH 03060, (603) 883-4157.

Circle 584 on inquiry card.

New Televideo Products

Televideo Systems has added four new items to its product line. The first, the Intelligent I, is a smart video-display terminal. It features 64K bytes of RAM (random-access read/write memory), which gives it local-processing capabilities. The Intelligent I has a suggested retail price of $1695. The second product, the Model 970 video-display terminal, is an extension of the company's Model 950 smart terminal. It has expanded memory and additional operating and printing functions.

The final two products are mass-storage devices for the TS806 computer, a multiuser system with 64K bytes of RAM, a 10-megabyte 5¼-inch Winchester disk drive, and a 500K-byte floppy-disk stroage unit. The TS806C is a tape-cartridge unit that provides 17.2 megabytes of backup tape-storage capacity. The TS806H gives the TS806 computer an additional 10-megabyte, 5¼-inch Winchester disk drive. The TS806C has a suggested retail price of $3995. The TS806H costs $3600. For complete details on these and other products, contact Televideo Systems Inc., 1170 Morse Ave., Sunnyvale, CA 94086, (408) 745-7760.

Circle 585 on inquiry card.

Video-Cassette Recorder Control Board

The AM-610 is a VCR (video cassette recorder) controller board that uses a standard VCR and video-cassette tapes for data backup and transfer of user-selected files. The AM-610 provides file-oriented backup and a directory, so users can selectively record or retrieve random and sequential files. A single video tape can back up as much as 100 megabytes of data, depending on the tape's length, the mixture of random and sequential files, and the amount of recording redundancy desired. When used with an Alpha Micro time-of-day clock and a programmable VCR, the AM-610 can provide automatic backup capabilities.

For complete details, contact Alpha Micro, 17881 Sky Park North, POB 18347, Irvine, CA 92713, (714) 957-1404.

Circle 586 on inquiry card.

Local-Network Component

The Model 71 is a short-haul modem that serves as a local-network component for any RS-232C device. It can operate at distances of 2 to 10 miles, at speeds of up to 9600 bps, full-duplex, using two twisted cable pairs, or simplex, using a single twisted pair. Designed for asynchronous operation, the network must provide DC continuity and be of the nonload type. The Model 71 draws its power from the host device.

In single units, the Model 71 costs $87; quantity discounts are available. For details, contact Remark Datacom Inc., 4 Sycamore Dr., Woodbury, NY 11797, (516) 367-3806.

Circle 587 on inquiry card.

MISCELLANEOUS

Manifest System Streamlines Shipping

The Parcel Manifest System is designed to streamline small package shipping. The system performs shipping functions such as weighing the parcel, calculating shipping charges, and selecting the least costly carrier; prints manifests; and compiles daily, monthly, and yearly shipping reports. The system consists of a Z80-based microcomputer, a line printer, an electronic scale that sends data directly through an RS-232C interface, and software. The standard unit is equipped to handle both UPS (United Parcel Service) and U.S. Postal Service carriers and is designed to manage 3000 parcels in an eight-hour period. Modules for other carriers are available.

The Parcel Manifest System costs $8995. For complete details, contact Tandata Corp., Suite Six, 3336 East 32nd St., Tulsa, OK 74135, (918) 747-2071.

Circle 588 on inquiry card.

Power-Line Monitor

The Inmac Power-Line Monitor can save you the expense of unnecessary repair calls by helping you determine whether a system shutdown is due to a faulty system or a power problem. The device keeps track of the power fed to computers and other sensitive equipment using 120 volts AC. It can pinpoint six different types of problems: power failure, low- or high-line voltage, voltage spikes or dropouts, and high-frequency noise. Line problems are indicated by LEDs (light-emitting diodes) and by a user-selectable alarm.

The Inmac Power-Line Monitor costs $295; quantity discounts are available. For details, contact Inmac Corp., Department 23, 2465 Augustine Dr., Santa Clara, CA 95051, (408) 727-1970.

Circle 589 on inquiry card.

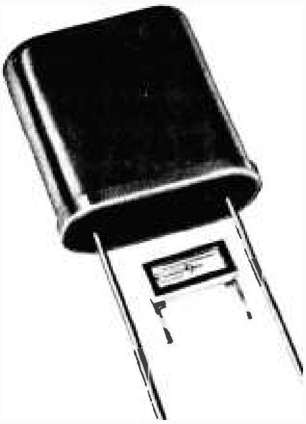
CP/M 2.2 for TRS-80 Model III

The CP/M 2.2 operating system is now available for the TRS-80 Model III, thanks to Parasitic Engineering. Shuffleboard III uses a memory-mapping technique that lets the TRS-80 use standard CP/M. It comes with 16K bytes of RAM (random-access read/write memory); 2K bytes of ROM (read-only memory) expandable to 8K bytes; and Maxi-Disk CP/M 2.2, which supports single- or double-density 5¼-inch disk drives and enhances the keyboard and screen. With the Maxi-Disk, the keyboard can generate all 128 ASCII (American Standard Code for Information Interchange) and all CP/M control characters. Additionally, the screen can handle both nondestructive cursor movements and direct cursor addressing.

Shuffleboard III plugs directly into two sockets within the TRS-80; soldering and cut traces are not required. Shuffleboard III costs $495, including manuals and installation instructions. For more information, contact Parasitic

What's New?

Engineering Inc., 1101 Ninth Ave., Oakland, CA 94606, (415) 839-2636.
Circle 590 on inquiry card.



Miniature Microprocessor Crystals

Statek has unvieled a series of 1-MHz to 1.25-MHz quartz crystals that are 48 times smaller than the industry-standard HC-33 crystal package. Designed primarily for microprocessor-clock circuits, the crystals occupy only 10 percent of the board space required by conventional crystals. A 1-MHz version, the CX-11, is available with leads in a low-profile, hermetically-sealed ceramic package for use in printed-circuit board construction. Another version is leadless and can be used for direct surface mounting on printed-circuit boards or hybrid circuits.

In ten-unit lots, the crystals cost $11.39 each. For details, contact Statek Corp., 512 North Main St., Orange, CA 92668, (714) 639-7810.
Circle 591 on inquiry card.

Computer Camps

The following is a list of computer camps and where to send for further information.

Champlain College Computer Camp, Room #4A, Box 670, 163 South Willard St., Burlington, VT 05402, (802) 658-0800.

Computer Camp, Registrar, J. Hamilton Welch Academy, 3049 McGregor Blvd., Fort Meyers, FL 33901, (813) 334-6044.

Computer Camp Inc., Suite G, 1235 Coast Village Rd., Santa Barbara, CA 93103, (800) 235-6965; in California, (805) 969-7871.

Family Computer Camp, Conference and Information Center, Clarkson College, Potsdam, NY 13676, (315) 268-6647.

Lake Forest Computer Camp, Lake Forest College, Sheridan and College Roads, Lake Forest, IL 60045, (312) 234-3100.

National Computer Camp, POB 624, Orange, CT 06477, (203) 795-3049 or (203) 795-9495.

Tar Heel Career Camps Inc., POB 2328, Chapel Hill, NC 27514, (919) 967-6996.

Virginia Tech Computer Camp, Carisa Blaylock, College of Education, 300 War Memorial Gym, Virginia Tech, Blacksburg, VA 24061, (703) 961-5587.

High-Speed UARTs

The COM 8018 and the COM 1863 are high-speed UARTs (universal asynchronous receivers/transmitters) that operate at data rates of up to 62.5 kbps (thousand bits per second) at a 1-MHz clock rate. The COM 8018 has a high-accuracy mode in which the master transmitter and receiver clocks are 32 times faster than the data, rather than the standard UART speed of 16 times. This allows a higher-distortion margin in the receiver-data sampling, which, in turn, improves the data accuracy in noisy environments. When its high-accuracy mode is disabled, the COM 8018 is pin-compatible with industry-standard UARTs. The COM 1863 has the same features as the 8018, with two exceptions: it does not have pull-up resistors or the high-accuracy mode.

Both devices are available in ceramic and plastic 40-pin DIPs (dual inline packages). In 100-unit lots, they cost $4.20 (plastic) and $13 (ceramic) each. Contact Standard Microsystems Corp., 35 Marcus Blvd., Hauppauge, NY 11788, (516) 273-3100.
Circle 592 on inquiry card.

Microcomputer Reference Cards

Foldable, shirt-pocket-sized microcomputer-system reference cards are available from Nanos Systems. Each card has a complete summary of the system as well as its reference manuals. The cards are printed on heavy-stock paper stretch-wrapped in plastic for protection. Cards are available for a wide assortment of systems, including TRS-80 Model I BASIC and assembler, PET BASIC, Heath H-8/89 BASIC, Sinclair ZX80/81, and Atari BASIC and assembler. Card prices range from $2.95 to $5.95; quantity discounts are available. For further details, contact Nanos Systems Corp., POB 24344, Speedway, IN 46224, (317) 244-4078.
Circle 593 on inquiry card.

Where Do New Products Items Come From?

The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgment the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. The information is printed more or less as a first-in first-out queue, subject to occasional priority modifications. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New?" feature is necessarily limited. We therefore cannot be responsible for product quality or company performance.

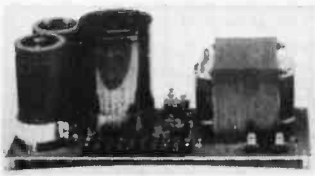
BYTE's Bugs

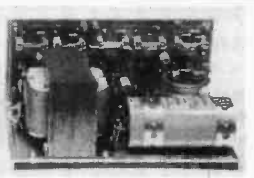
New Address Correct Price

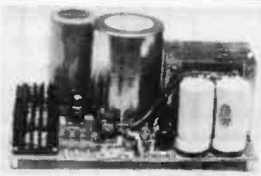
The new address for the Datasouth Computer Corporation is POB 240947, Charlotte, NC 28224. Also, the DS180 printer, mentioned in the March 1982 BYTE (see page 483), costs $1595. We apologize for this error.■

Circle 429 on inquiry card.

SUNNY LOW LOW COST
POWER SUPPLIES
(LINEAR & SWITCHING)
FOR S-100, DISK DRIVES


KIT 1, 2 & 3 For S–100


R3 For Three 8" or 5¼" Disk Drives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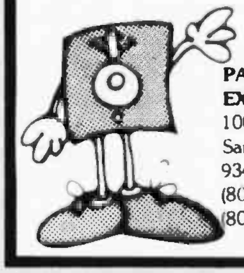

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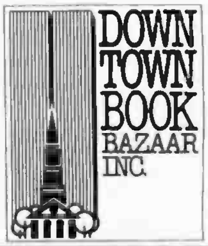

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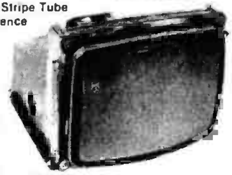

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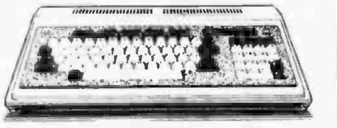

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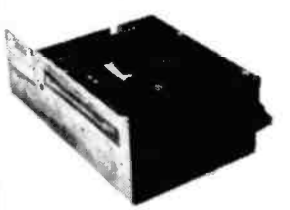

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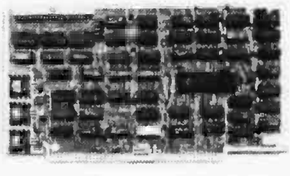

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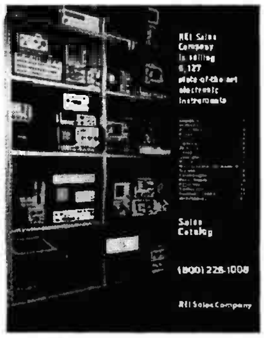

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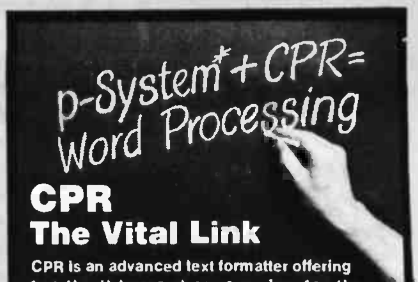

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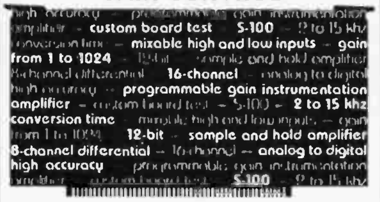

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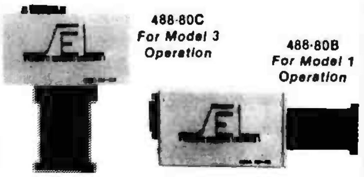

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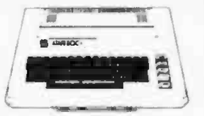

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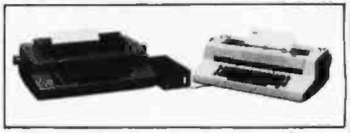

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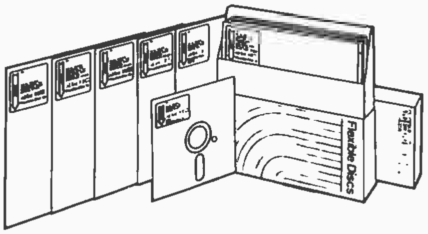

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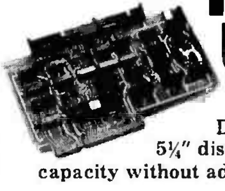

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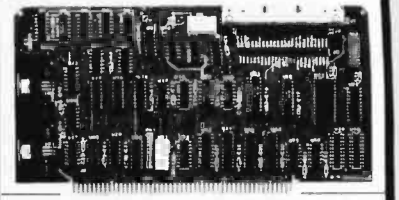

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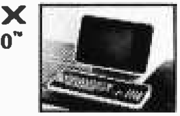

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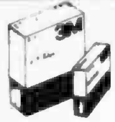

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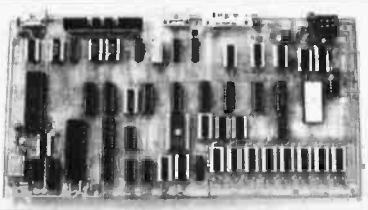

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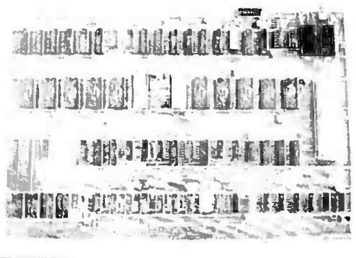

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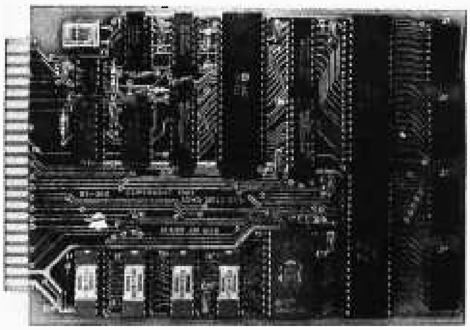

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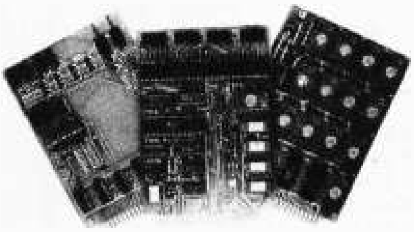

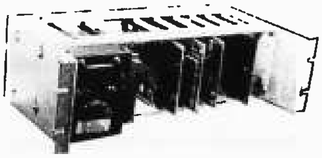

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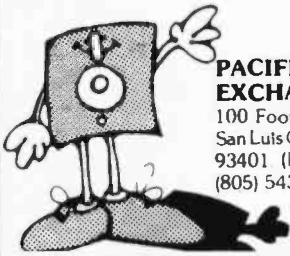

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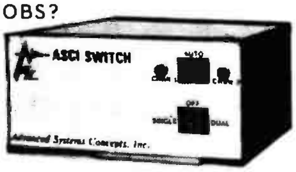

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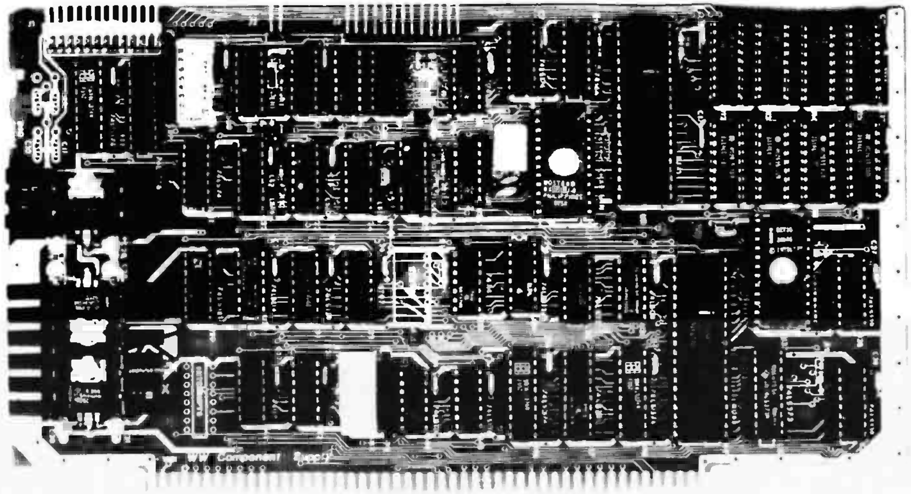

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The VIO-X2 also offers an 80 character by 25 line format but uses a 7 × 7 character set in a 9 × 10 dot matrix allowing high-resolution characters to be used. This model also includes expanded firmware for block mode editing and light pen location. Contiguous graphics characters are not supported.

Both models support a full set of control characters and escape sequences, including controls for video attributes, cursor location and positioning, cursor toggle, and scroll speed. An onboard Real Time Clock (RTC) is displayed in the status line and may be read or set from the host system. A checksum test is performed on power-up on the firmware EPROM.

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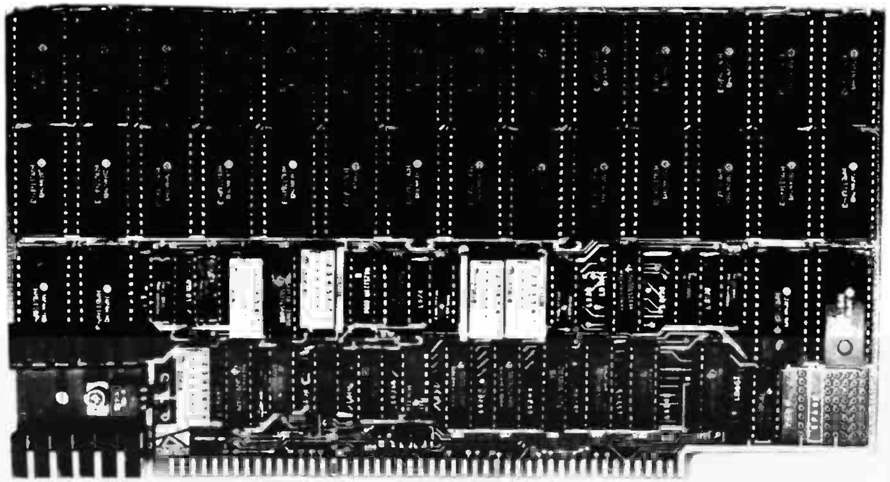

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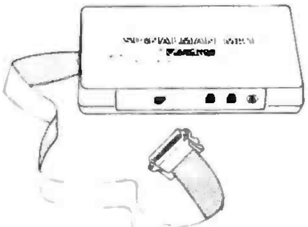

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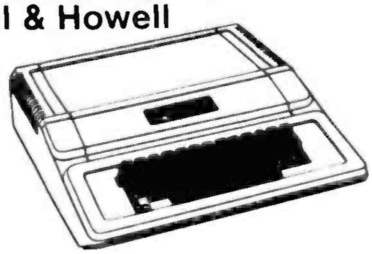

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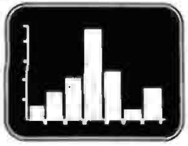

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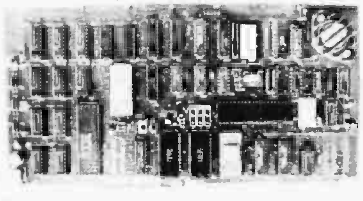

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VENTURE is a 16" by 20" main board with separate ASCII and HEX keyboards. It runs fast, almost 4 MHz, and has the capability of putting almost 1 megabyte of RAM and ROM on the board along with a variety of inexpensive options.

A 16-channel analog-to-digital converter allows use of joysticks, control functions, instrumentation, temperature sensing, etc. T1 sound generator, software controlled music, Votrax voice synthesizer and real time clock calendar add to its versatility.

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VENTURE connects directly to a monitor or to your TV set through an RF modulator. And now for the heart of VENTURE . . . its video display. VENTURE has a high resolution programmable video display with up to 4096 user-defined characters, alphanumeric symbols, special graphics or objects, such as space ships, etc. Each character is 8 pixels wide by 15 pixels high, with 2 grayscale maps; it has 64 levels of grayscale plus video invert/compliment and hidden screen update for a "snow" free display. The display is 512 x 512 pixel mapped with 2 planes of video RAM per display. VENTURE video is in short . . . astounding!

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Expansion Options

Floppy disk, EPROM programmer, light pen, universal user programmable music, sound board high resolution color/grayscale pixel mapped video board, General Purpose Instrument Bus.

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Kit includes CPU and control with 4K of RAM, 1K of scratchpad, 2K monitor, 1861 video graphics, cassette interface and separate HEX keyboard with LED displays for address and output. Power supply is included along with 2 game cassettes. The main board is 16" x 20" and includes space for all of the previously discussed on-board options. Full on-board expansion can be completed for under $1000.00. Call for further details, option prices, etc.

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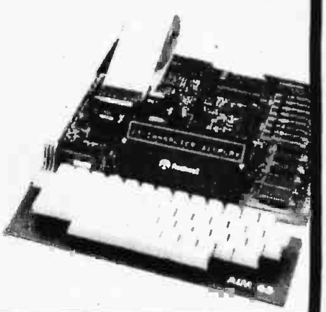

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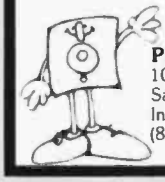

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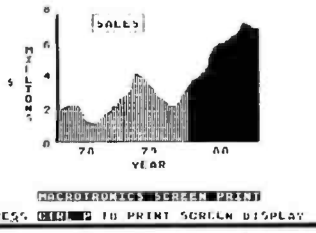

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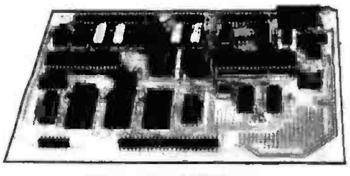

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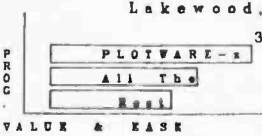

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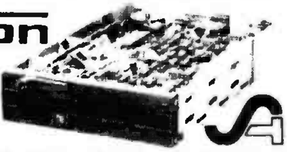

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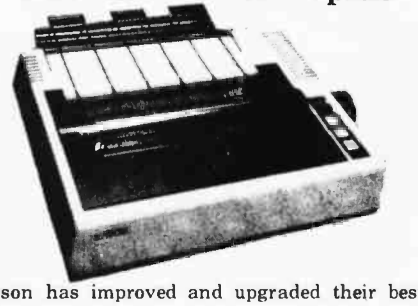

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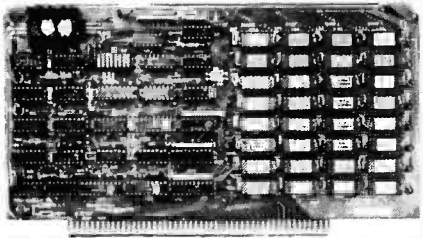

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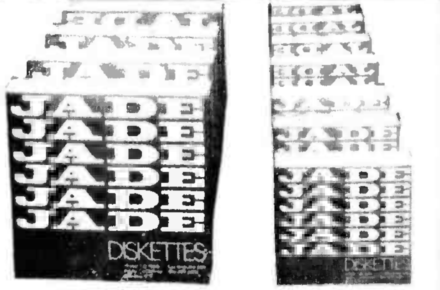

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16K MEMORY UPGRADE

Add 16K of RAM to your TRS-80, Apple, or Exidy in just minutes. We've sold thousands of these 16K RAM upgrades which include the appropriate memory chips (as specified by the manufacturer), all necessary jumper blocks, fool-proof instructions, and our 1 year guarantee.

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16K RAM CARD - for Apple II

Expand your Apple to 64K, 1 year warranty

MEX-16700A	*Save $125.00 !!!*	**$74.95**

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Two computers in one, Z-80 & 6502, more than doubles the power & potential of your Apple, includes Z-80 CPU card, CP/M 2.2, & BASIC-80*

CPX-30800A	*A & T*	**$299.95**

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New from Vista Computer, single or double sided, single or double density, compatible with DOS 3.2/3.3, Pascal, & CPM 2.2, Shugart & Qume compatible

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Complete package includes: Two 8" double-density disk drives, Vista double-density 8" disk controller, cabinet, power supply, & cables, DOS 3.2/3.3, CP/M 2.2, & Pascal compatible.

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IOM-5232A	*Save $50.00!!!*	**$334.95**

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IOD-2370A	*Micro Sci A70*	**$499.95**

Micro Sci Controller *Disk controller for up to two Micro Sci A40 or A70 disk drives, DOS 3.2, 3.3, Pascal, and Z-80 SoftCard compatible, includes utility disk and 40/70 track patch.*

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80 column x 24 line video card for Apple II, 128 ASCII characters, upper and lower case, 9 x 10 dot matrix with 3 dot descenders, standard data media terminal control codes, CP/M Pascal & Fortran compatible, 50/60 Hz

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A better joystick for your Apple II

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Three cards in one! Real time clock/calendar, serial interface, & parallel interface - all on one card.

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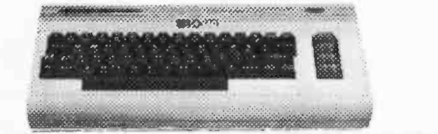

Complete personal computer with 5K RAM, full color, 61 key keyboard, 4 dual special-function keys, serial ports, cassette port, composite video output (connects to standard color TV set), BASIC language, & expansion port.

COM-VIC20	*VIC-20*	**$279.95**

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Complete Z-80 microcomputer with RAM, ROM, I/O, keyboard, display, kludge area, manual, & workbook

CPS-30100K	*KIT*	**$299.95**
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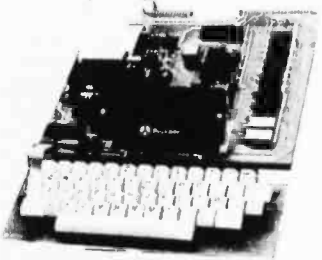

AIM-65 - Rockwell

6502 computer with alphanumeric display, printer, & keyboard, and complete instructional manuals

CPK-50165A	*1K AIM-65*	**$424.95**
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CPU-30200B	*Bare board*	$35.00

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2/4 MHz Z-80A CPU with RS-232C serial I/O port and on-board MOSS 2.2 monitor PROM, front panel compatible.*

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2 or 4 MHz Z-80 CPU board with provision for up to 8K of ROM or 4K of RAM on board. extended addressing. IEEE S-100, front panel compatible.

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CPU-30300A	*A & T*	$299.95

16K STATIC RAM - Mem Merchant

4 MHz 16K static RAM board. IEEE S-100. bank selectable. Phantom capability. addressable in 4K blocks. "disable-able" in 1K segments. extended addressing. low power

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MEM-32731K	*32K Kit*	$239.95
MEM-64733K	*64K Kit*	$279.95
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4 MHz bank port / bank byte selectable, extended addressing, 16K bank selectable. PHANTOM line allows memory overlay. 8080 / Z-80 / front panel compatible.

MEM-64565A	*A & T*	$389.95

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MEM-64400A	*A & T*	$594.95

64K STATIC RAM - SSM

IEEE 696/S-100 standard. up to 6MHz/8 Bit. 12MHz/16 Bit. 24 Bit extended addressing. disable-able in 2K increments

MEM-64300A	*A & T*	$749.95

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Absolute IEEE 696/S-100 compliance. 8 or 16 Bit data paths. 16-bit request acknowledge properly implemented. supports DMA at 8MHz. switchable bank select system for use with Cromemco & Alpha Micro

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Double density disk controller for any combination of 5¼" or 8" single or double sided disk drives. analog phase-locked loop data separator. vectored interrupt. CP/M 2.2 & OASIS compatible, control/diagnostic software PROM included

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Double density controller with the inside track, on-board Z-80A. printer port. IEEE S-100, can function on an interrupt driven buss*

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IOD-1200A	*A & T*	$375.00
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5¼" and 8" disk controller. single or double density, with on-board boot loader ROM. and free CP/M 2.2 and manual set.*

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I/O-5 - SSM Microcomputer

Two serial & 3 parallel I/O ports. 110-19.2K Baud

IOI-1015A	*A & T*	$279.95

I/O-8 - SSM Microcomputer

Eight software programmable serial I/O ports. 110 -19.2K Baud. ideal for multi-user systems

IOI-1018A	*A & T*	$449.95

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2708. 2716. 2732 EPROM programmer w/software

MEM-99520K	*Kit*	$189.95
MEM-99520A	*A & T*	$249.95

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EPROM BOARD - Jade

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MBS-121K	*Kit*	$69.95
MBS-121A	*A & T*	$89.95
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MBS-181B	*Bare board*	$49.95
MBS-181K	*Kit*	$99.95
MBS-181A	*A & T*	$139.95

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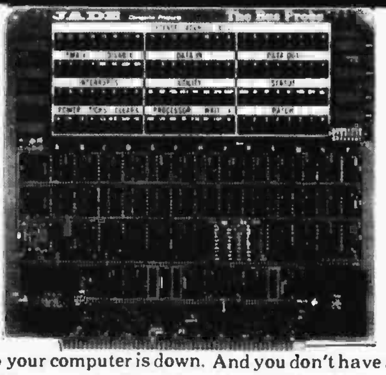

So your computer is down. And you don't have an oscilloscope. And you don't have a front panel... You're not alone - most computers have their occasional bad days. But without diagnostic equipment such as an oscilloscope (expensive!) or a front panel (expensive!), it can be very difficult to pinpoint the problem. Even if you have an extender board with a superfast logic probe, you can't see more than one signal at a time. You're stuck, right?

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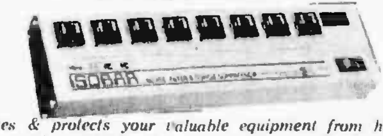

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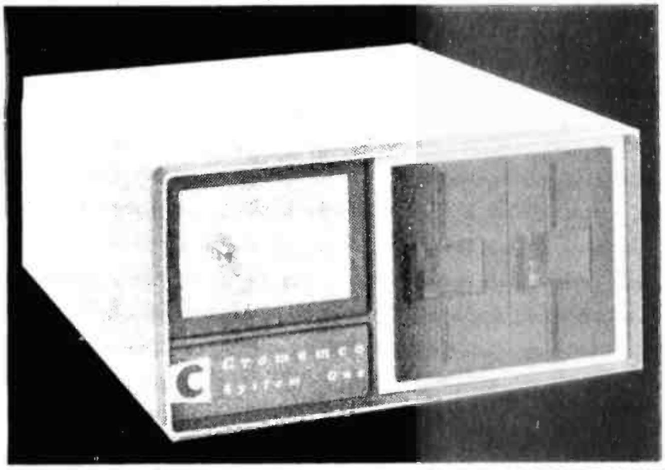

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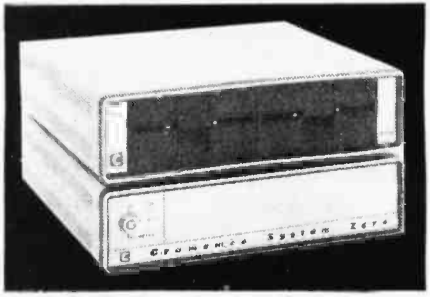

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SUPERBRAINS come with CP/M; with the addition of an appropriate printer, and the necessary software you can have a complete data processing and /or word processing system.

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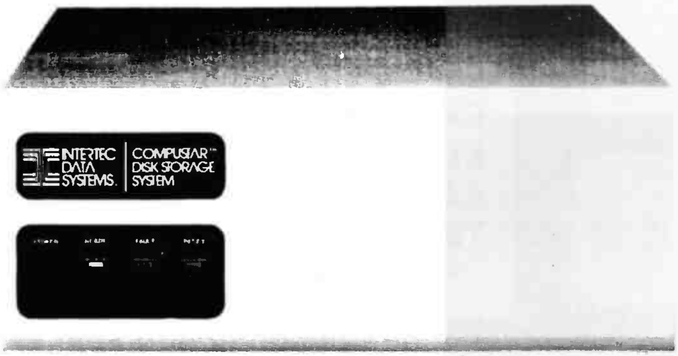

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7409	.19	74152	.65
7410	.19	74153	.55
7411	.25	74154	1.40
7412	.30	74155	.75
7413	.35	74156	.65
7414	.55	74157	.55
7416	.25	74159	1.65
7417	.25	74160	.85
7420	.19	74161	.70
7421	.35	74162	.85
7422	.29	74163	.85
7423	.29	74164	.85
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7432	.29	74173	.75
7433	.45	74174	.89
7437	.29	74175	.89
7438	.29	74176	.89
7440	.19	74177	.75
7442	.49	74178	1.15
7443	.65	74179	1.75
7444	.69	74180	.75
7445	.69	74181	2.25
7446	.59	74182	.75
7447	.69	74184	2.00
7448	.69	74185	2.00
7450	.19	74186	18.50
7451	.23	74190	1.15
7453	.23	74191	1.15
7454	.23	74192	.79
7460	.23	74193	.79
7470	.35	74194	.85
7472	.29	74195	.85
7473	.34	74196	.79
7474	.35	74197	.75
7475	.49	74198	1.35
7476	.35	74199	1.35
7480	.59	74221	1.35
7481	1.10	74246	1.35
7482	.95	74247	1.25
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7485	.65	74249	1.95
7486	.35	74251	.75
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7490	.35	74265	1.35
7491	.40	74273	1.95
7492	.50	74276	1.25
7493	.49	74279	.75
7494	.65	74283	2.00
7495	.55	74284	3.75
7496	.70	74285	3.75
7497	2.75	74290	.95
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74109	.45	74351	2.25
74110	.45	74365	.65
74111	.55	74366	.65
74116	1.55	74367	.65
74120	1.20	74368	.65
74121	.29	74376	2.20
74122	.45	74390	1.75
74123	.55	74393	1.35
74125	.45	74425	3.15
74126	.45	74426	.85
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CMOS

74C00	.35	4019	.45
74C02	.35	4020	.95
74C04	.35	4021	.95
74C08	.35	4022	1.15
74C10	.35	4023	.35
74C14	1.50	4024	.75
74C20	.35	4025	.35
74C30	.35	4026	1.65
74C32	.50	4027	.65
74C42	1.75	4028	.80
74C48	1.20	4029	.95
74C73	.65	4030	.45
74C74	.85	4034	2.95
74C76	.80	4035	.85
74C83	1.95	4040	.95
74C85	1.95	4041	1.25
74C86	.95	4042	.75
74C89	4.50	4043	.85
74C90	1.75	4044	.85
74C93	1.75	4046	.95
74C95	1.75	4047	.95
74C107	1.00	4049	.55
74C150	5.75	4050	.55
74C151	2.25	4051	.95
74C154	3.25	4053	.95
74C157	1.75	4060	1.45
74C160	2.00	4066	.75
74C161	2.00	4068	.40
74C162	2.00	4069	.35
74C163	2.00	4070	.35
74C164	2.00	4071	.30
74C165	2.00	4072	.30
74C173	2.00	4073	.30
74C174	2.25	4075	.30
74C175	2.25	4076	.95
74C192	2.25	4078	.30
74C193	2.25	4081	.30
74C195	2.25	4082	.30
74C200	5.75	4085	.95
74C221	2.25	4086	.95
74C373	2.75	4093	.95
74C374	2.75	4098	2.49
74C901	.80	4099	1.95
74C902	.85	14409	12.95
74C903	.85	14410	12.95
74C905	10.95	14411	11.95
74C906	.95	14412	12.95
74C907	1.00	14419	4.95
74C908	2.00	4502	.95
74C909	2.75	4503	.65
74C910	9.95	4508	1.95
74C911	10.00	4510	.95
74C912	10.00	4511	.95
74C914	1.95	4512	.95
74C915	2.00	4514	1.25
74C918	2.75	4515	2.25
74C920	17.95	4516	1.55
74C921	15.95	4518	1.25
74C922	5.59	4519	1.25
74C923	5.95	4520	1.25
74C925	6.75	4522	1.25
74C926	7.95	4526	1.25
74C927	7.95	4527	1.95
74C928	7.95	4528	1.25
74C929	19.95	4531	.95
74C930	19.95	4532	1.95
4000	.35	4538	1.95
4001	.35	4539	1.95
4002	.25	4543	2.70
4006	.95	4555	.95
4007	.29	4556	.95
4008	.95	4581	1.95
4009	.45	4582	1.95
4010	.45	4584	.95
4011	.35	4584	.95
4012	.25	4702	12.95
4013	.45	4724	1.50
4014	.95	80C07	.95
4015	.95	80C95	.85
4016	.45	80C96	.95
4017	1.15	80C97	.95
4018	.95	80C98	1.20

74S00 SERIES

74S00	.44	74S85	2.39	74S163	3.75	74S280	2.90
74S02	.48	74S86	1.44	74S168	4.65	74S287	4.75
74S03	.48	74S112	1.59	74S169	5.44	74S288	4.45
74S04	.79	74S113	1.98	74S174	1.09	74S289	6.98
74S05	.79	74S114	1.50	74S175	1.09	74S301	8.95
74S08	.48	74S124	2.77	74S181	4.47	74S373	3.45
74S09	.98	74S132	1.24	74S182	2.95	74S374	3.45
74S10	.69	74S133	.98	74S188	3.95	74S381	7.95
74S11	.88	74S134	.69	74S189	14.95	74S387	5.75
74S15	.70	74S135	1.48	74S194	2.95	74S412	2.98
74S20	.68	74S138	1.08	74S195	1.89	74S471	9.95
74S22	.98	74S139	1.25	74S196	4.90	74S472	16.85
74S30	.48	74S140	1.45	74S197	4.25	74S474	17.85
74S32	.98	74S241	3.75	74S201	14.95	74S482	15.60
74S37	1.87	74S244	3.98	74S225	8.95	74S570	7.80
74S38	1.68	74S251	1.90	74S240	3.98	74S571	7.80
74S40	.44	74S253	7.45	74S257	1.39		
74S51	.78	74S157	1.19	74S258	1.49		
74S64	.79	74S158	1.45	74S260	1.83		
74S65	1.25	74S161	2.85	74S274	19.95		
74S74	.69	74S162	3.70	74S275	19.95		

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.99	MAN 72	.3"	CA	14 Pin .3"
.99	MAN 74	.3"	CC	14 Pin .3"
.75	FND-357 (359)	.375"	CC	10 Pin .2"
.99	FND-500 (503)	.5"	CC	10 Pin .6"
.99	FND-507 (510)	.5"	CA	10 Pin .6"

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FRIENDLY STAFF! To make doing business with JDR a pleasant experience.

SPEEDY SERVICE! To speed your order on its way in one day with superb accuracy.

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●●●●.....

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8''

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The 8086 Book	16.99

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The CP/M Handbook	14.95
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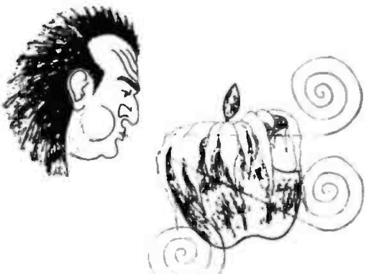

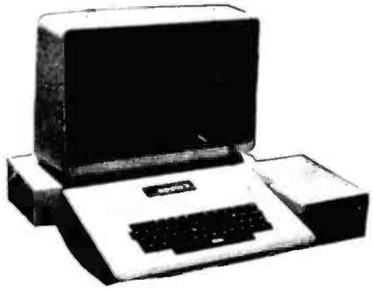

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STATIC RAMS

			Each	100 pcs
2101	256 x 4	(450ns)	1.95	1.85
5101	256 x 4	(cmos) (450ns)	4.95	3.95
2102-1	1024 x 1	(450ns)	.89	.85
2102L-2	1024 x 1	(LP) (250ns)	1.69	1.55
2102L-4	1024 x 1	(LP) (450ns)	1.29	1.15
2111	256 x 4	(450ns)	2.99	2.49
2112	256 x 4	(450ns)	2.99	2.79
2114	1024 x 4	(450ns)	8/16.95	1.95
2114L-2	1024 x 4	(LP) (200ns)	8/19.95	2.35
2114L-3	1024 x 4	(LP) (300ns)	8/18.95	2.25
2114L-4	1024 x 4	(LP) (450ns)	8/17.95	2.10
2147	4096 x 1	(55ns)	9.95	call
TMS4044-4	4096 x 1	(450ns)	3.49	3.25
TMS4044-3	4096 x 1	(300ns)	3.99	3.75
TMS40L44-2	4096 x 1	(LP) (200ns)	4.49	4.25
MK4118	1024 x 8	(250ns)	9.95	call
TMM2016	2048 x 8	(150ns)	call	call
HM6116-4	2048 x 8	(cmos) (200ns)	call	call
HM6116-3	2048 x 8	(cmos) (150ns)	call	call
HM6116-2	2048 x 8	(cmos) (120ns)	call	call
HM6116LP-4	2048 x 8	(LP) (cmos) (200ns)	call	call
HM6116LP-3	2048 x 8	(LP) (cmos) (150ns)	call	call
HM6116LP-2	2048 x 8	(LP) (cmos) (120ns)	call	call
Z-6132	4096 x 8	(Qstat) (300ns)	34.95	call

LP = Low Power Qstat = Quasi-Static

DYNAMIC RAMS

			Each	100 pcs
TMS4027	4096 x 1	(250ns)	2.50	2.00
MK4108	8192 x 1	(200ns)	1.95	call
MM5298	8192 x 1	(250ns)	1.85	call
4116-120	16384 x 1	(120ns)	8/29.95	call
4116-150	16384 x 1	(150ns)	8/18.95	1.95
4116-200	16384 x 1	(200ns)	8/13.95	call
4116-250	16384 x 1	(250ns)	8/13.90	call
4116-300	16384 x 1	(300ns)	8/13.80	call
2118	16384 x 1	(5v) (150ns)	4.95	call
MK4816	2048 x 8	(5v) (300ns)	24.95	call
4164-200	65536 x 1	(5v) (200ns)	call	call
4164-150	65536 x 1	(5v) (150ns)	call	call

EPROMS

			Each	8 pcs
1702	256 x 8	(1us)	4.95	4.50
2708	1024 x 8	(450ns)	3.75	3.50
2758	1024 x 8	(5v) (450ns)	9.95	8.95
TMS2516	2048 x 8	(5v) (450ns)	6.95	5.95
2716	2048 x 8	(5v) (450ns)	4.95	3.95
2716-1	2048 x 8	(5v) (350ns)	9.00	8.50
TMS2716	2048 x 8	(450ns)	9.95	8.95
TMS2532	4096 x 8	(5v) (450ns)	9.95	7.95
2732	4096 x 8	(5v) (450ns)	9.95	7.95
2732A-2	4096 x 8	(5v) (200ns)	call	call
2764	8192 x 8	(5v) (450ns)	call	call
TMS2564	8192 x 8	(5v) (450ns)	call	call

5v = Single 5 Volt Supply

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/CM²)	
PE-14		6	5,200	83.00
PE-14T	X	6	5,200	119.00
PE-24T	X	9	6,700	175.00
PL-265T	X	20	6,700	255.00
PR-125T	X	16	15,000	349.00
PR-320T	X	32	15,000	595.00

JUNE SPECIALS

2K x 8 STATIC

TMM-2016 (200NS)

8/6.95 EA.

HM6116 (200NS)

8/7.95 EA.

64K DYNAMIC

4164 (200NS)

8/8.95 EA.

16K DYNAMIC

4116 (200NS)

8/13.95 EA.

16K EPROMS

2716 (450NS)

8/3.95 ea.

32K EPROMS

2532 or 2732
(450NS)

8/7.95 EA.

PRICES GOOD FOR THE MONTH OF JUNE ONLY
PLEASE MENTION JUNE SPECIALS WHEN ORDERING.

PROMS

Order by National Part No.	Function	EQUIVALENT PART NUMBERS TI	SIG	MMI	Harris	
74S188	32x8 OC	18SA030	82S23	6330-1	7602	2.95
74S287	256x4 TS	14S10	82S129	6301-1	7611	3.25
74S288	32x8 TS	18S030	82S123	6331-1	7603	2.75
74S387	256x4 OC	14SA10	82S126	6300-1	7610	2.95
74S471	256x8 TS	18S22		6309-1		10.95
74S472	512x8 TS	18S42	82S147	6349-1	7649	10.95
74S473	512x8 OC	18SA42	82S146	6348	7648	10.95
74S474	512x8 TS	18S46	82S141	6341	7641	12.95
74S475	512x8 TS	18SA46	82S140	6340	7640	12.95
74S478	1Kx8 TS	28S86				19.95
74S570	512x4 OC	27S12	82S130	6305	7620	5.95
74S571	512x4 TS	27S13	82S131	6306-1	7621	5.95
74S572	1kx4 OC	24SA41	82S136	6352-1	7642	9.95
74S573	1kx4 TS	24S41	82S137	6353-1	7643	9.95
87S180	1kx8 OC	28SA86	82S180	6380-1	7680	19.25
87S181	1kx8 TS	28S86	82S181	6381-1	7681	16.25
87S184	2kx4 OC	24SA81	82S184		7684	17.20
87S185	2kx4 TS	24S81	82S185		7685	16.95
87S190	2kx4 OC	28SA166	82S190		76160	39.95
87S191	2kx8 TS	28S166	82S191		76161	39.95

74LS00 SERIES

74LS00	.25	74LS169	1.75
74LS01	.25	74LS170	1.75
74LS02	.25	74LS173	.80
74LS03	.25	74LS174	.95
74LS04	.25	74LS175	.95
74LS05	.25	74LS181	2.15
74LS08	.35	74LS189	9.95
74LS09	.35	74LS190	1.00
74LS10	.25	74LS191	1.00
74LS11	.35	74LS192	.85
74LS12	.35	74LS193	.95
74LS13	.45	74LS194	1.00
74LS14	1.00	74LS195	.95
74LS15	.35	74LS196	.85
74LS20	.25	74LS197	.85
74LS21	.35	74LS221	1.20
74LS22	.25	74LS240	1.29
74LS26	.35	74LS241	1.29
74LS27	.35	74LS242	1.85
74LS28	.35	74LS243	1.85
74LS30	.25	74LS244	1.29
74LS32	.35	74LS245	1.90
74LS33	.55	74LS247	.75
74LS37	.55	74LS248	1.25
74LS38	.35	74LS249	.99
74LS40	.35	74LS251	1.30
74LS42	.55	74LS253	.85
74LS47	.75	74LS257	.85
74LS48	.75	74LS258	.85
74LS49	.75	74LS259	2.85
74LS51	.25	74LS260	.65
74LS54	.35	74LS266	.55
74LS55	.35	74LS273	1.65
74LS63	1.25	74LS275	3.35
74LS73	.40	74LS279	.55
74LS74	.45	74LS280	1.98
74LS75	.50	74LS283	1.00
74LS76	.40	74LS290	1.25
74LS78	.50	74LS293	1.85
74LS83	.75	74LS295	1.05
74LS85	1.15	74LS298	1.20
74LS86	.40	74LS324	1.75
74LS90	.65	74LS352	1.55
74LS91	.89	74LS353	1.55
74LS92	.70	74LS363	1.35
74LS93	.65	74LS364	1.95
74LS95	.85	74LS365	.95
74LS96	.95	74LS366	.95
74LS107	.40	74LS367	.70
74LS109	.40	74LS368	.70
74LS112	.45	74LS373	1.75
74LS113	.45	74LS374	1.75
74LS114	.50	74LS377	1.45
74LS122	.45	74LS378	1.18
74LS123	.95	74LS379	1.35
74LS124	2.99	74LS385	1.90
74LS125	.95	74LS386	.65
74LS126	.85	74LS390	1.90
74LS132	.75	74LS393	1.90
74LS136	.55	74LS395	1.65
74LS137	.99	74LS399	1.70
74LS138	.75	74LS424	2.95
74LS139	.75	74LS447	.37
74LS145	1.20	74LS490	1.95
74LS147	2.49	74LS624	3.99
74LS148	1.35	74LS668	1.69
74LS151	.75	74LS669	1.89
74LS153	.75	74LS670	2.20
74LS154	2.35	74LS674	9.65
74LS155	1.15	74LS682	3.20
74LS156	.95	74LS683	2.30
74LS157	.75	74LS684	2.40
74LS158	.75	74LS685	2.40
74LS160	.90	74LS688	2.40
74LS161	.95	74LS689	2.40
74LS162	.95	74LS783	24.95
74LS163	.95	81LS95	1.69
74LS164	.95	81LS96	1.69
74LS165	.95	81LS97	1.69
74LS166	2.40	81LS98	1.69
74LS168	1.75		

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PN2222	10/1.00	100/ 8.99
2N2222	.25	50/10.99
2N2907	.25	50/10.99
2N3055	.79	10/ 6.99
2N3904	10/1.00	100/ 8.99
2N3906	10/1.00	100/ 8.99
1N4148 (1N914)		25/ 1.00
1N4004		10/ 1.00

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Z80-CPU	6.00
Z80-CTC	5.95
Z80-DART	15.25
Z80-DMA	17.50
Z80-PIO	6.00
Z80-SIO/O	18.50
Z80-SIO/1	18.50
Z80-SIO/2	18.50
Z80-SIO/9	16.95

4.0 Mhz

Z80-A-CPU	6.00
Z80-CTC	8.65
Z80A-DART	18.75
Z80A-DMA	27.50
Z80A-PIO	6.00
Z80A-SIO/O	22.50
Z80A-SIO/1, O	22.50
Z80A-SIO½2	22.50
Z80A-SIO/9	19.95

6.0 Mhz

Z80B-CPU	17.95
Z80B-CTC	15.50
Z80B-PIO	15.50

ZILOG

Z6132	34.95
Z8	39.95

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

ST = SOLDERTAIL

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

8200

8202	34.95
8205	3.50
8212	1.85
8214	3.85
8216	1.80
8224	2.50
8226	1.80
8228	4.90
8237	19.95
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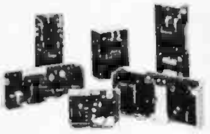

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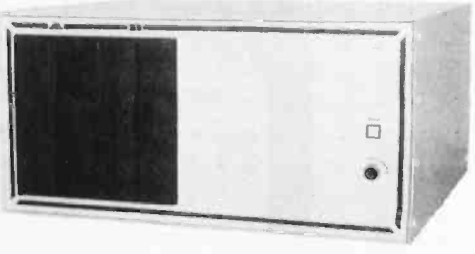

(Less Drives, Cables Pick-up Price)
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★ DUAL DRIVE SUBSYSTEMS ★

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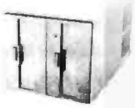
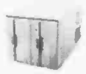


VERTICAL



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- Power Supply for 2 801/851 DT8 etc.
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S-100 MOD KIT $199.00
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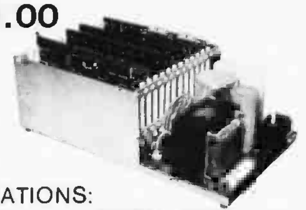
For test or hobby applications complete S-100 12 Slot Sub-System power for up to 4 Floppy Disk Drives. (6 connectors supplied.)



SPECIFICATIONS:

UNREGULATED	REGULATED
• 12 Slots S-100	+5 at 5 Amps
• +8VDC at 30Amps	+24 at 4 Amps
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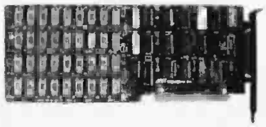

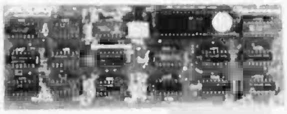

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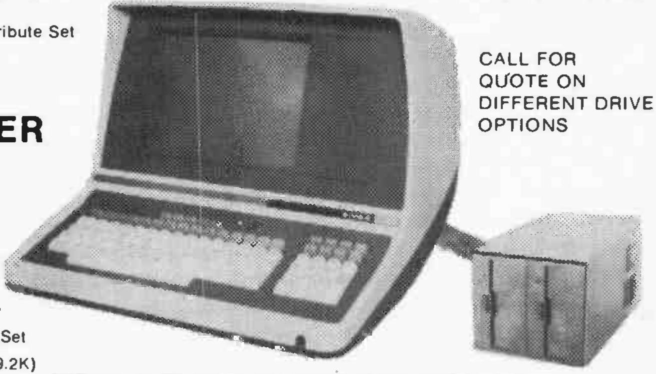

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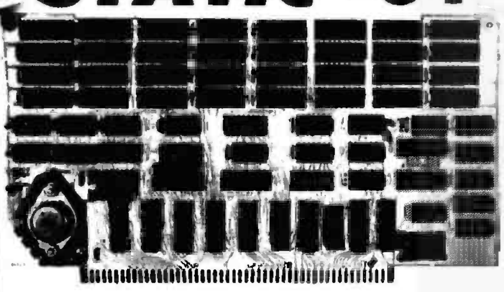

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Sixteen Bit Memory

$595

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30% Price Reduction

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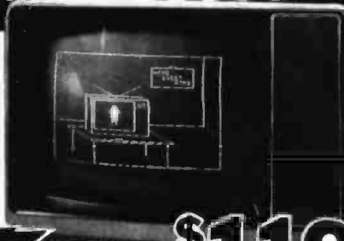

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Accepts composite video and is fully compatable with 80 column Apple cards.
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NEC PC-8023A

$535

Dot-matrix, bi-directional, logic-seeking, friction or tractor feed, impact printer. Complete graphics, upper and lower case ASCII, Greek, mathematics along with the ability to print dot graphic screen images directly onto paper.

Proportional spacing and 132 column compressed print make this low cost machine the best value in todays printer market.

PRINTRONIX

P-300 $4500

P-600 $6150

PRINTERS

Epson MX80	PREMX80	$475
Epson MX80FT	PREMX80F	595
Epson MX100	PREMX100	
Anadex 9500	PRA9500	1295
Anadex 9501	PRA9501	1295
Anacom 150	PRA150	1075
IDS Paper Tgr.	PRG460G	1095
IDS Tiger 560	PRG560G	1350
Diablo 630	PRD630	2150
Diablo 1650	PRD1650	2850
Diablo 1640	PRD1640	2496
Datasouth 180	PRD180	1350
Printronix 300	PRP300	4500
Printronix 600	PRP600	6150
NEC/Sellum 1	PRN5510ps	2695
NEC/Sm 16K	PRN5516ps	2795
TEC/Starwrit.	PRV300	1395
Okidata 80	PRO80	419
Okidata 82	PRO82	619
Okidata 83	PRO83	895
Teletype 43K	PTT4320K	1095
Texas Ins. 810	PRT810B	1450
Tex. Ins 810C	PRT810C	1795
Centronics 730	PRC730P	529
Centronics 737	PRC737P	695
Centronics 739	PRC739P	795
Centrnx 704-9	PRC704-9	
Centrnx.704-11	PRC704-11	

SYSTEMS

HEWLETT PACKARD

HP 85 COMPUTER

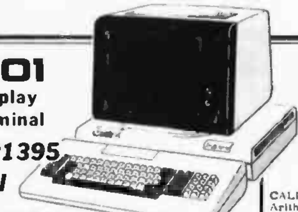
BELOW OUR COST

$2295

apple

48K Memory

$1150



IBM 3101

Display Terminal

IBM Direct Price $1395

California Digital

discount price **$1295**

AMPEX

DIALOGUE 80

REDUCED PRICE

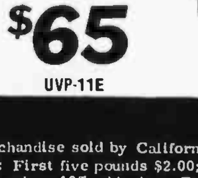
$795

New from the Ampex Corporation. The Dialogue 80 features removable keyboard, displayable two pages (four optional) dual program keys, half intensity protected fields and status line. Transmits data either block, line or character mode. Excellent value. VDT-D80 shipping 47 lbs.

VIDEO TERMINALS

ADDS Viewpoint	VDT-RVP	595
ADDS Regent 25 numeric cluster	VDT-R25	850
ADDS Regent 30 25th status line	VDT-R30	950
ADDS Regent 40 limited graphics	VDT-R40	1195
ADDS Regent 60 Block mode	VDT-R60	1495
Ampex Dialouge 80 two page, detatch	VDT-D80	
Digital Equipment VT-100	VDT-V100	1595
Digital Equipment VT-132	VDT-V132	1895
IBM 3101-10 character mode green	VDT-3101	1195
IBM 3101-20 block mode	VDT-31012	1395
Visual 200	VDT-V200	995
Televideo 910C (new)	VDT-T910	595
Televideo 912C	VDT-T912	665
Televideo 920C	VDT-T920	745
Televideo 950C detatchable keybd.	VDT-T950	985
Zenith Z-19	VDT-Z-19	

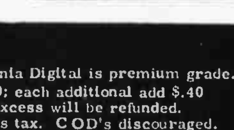
VIDEO MONITORS



BMC KG-12C 20 MHz P31 green phosphor	$169
NEC gm. 1201	189
Zenith gm ZVM121	119
BMC color composit	339
Zenith color 13"	395
NEC RGB 1202DH	895

EPROM ERASER

Ultra Vilot Products

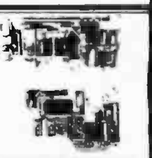


$65

UVP-11E

ACCESSORIES FOR THE

APPLE COMPUTER



CALIFORNIA COMPUTER SYSTEMS	
Arithmetic Processor 7811 B/C	$319
Asynchronous serial interface 7710	129
Centronics Interface card 7728	95
12K PROM Module 7114	69
Calender/Clock, Bat. back-up 7424	99
Parallel Interface 7720A	99
Programable Timer 7740A	99
Analog/Digital converter 7470A	99
MICROSOFT PRODUCTS	
Apple to Z-80 CPU card	379
D. C. HAYES PRODUCTS	
Micromodem for Apple	319
COMPUTER STOP PRODUCTS	
Double Vision / 80 Column Video	250
INTERACTIVE STRUCTURES	
16 Channel A/D card AIO/2	275
MOUNTAIN COMPUTER PRODUCTS	
Intro X-10 system for BSR	$239
Intro X-10 card only	165
16 channel AD/DA 8 bit	319
Apple Clock battery back-up	225
Supertalker SD200	249
ROM Plus with filter	165
ROM Writer/Programmer	149
APPLE BRAND PRODUCTS	
Apple Language card	450
Floppy disk with controller	560
Floppy disk without controller	495
Apple parallel interface	175
SSM MICROCOMPUTER	
Dual serial parallel interface AIO	
SORRENTO VALLEY ASSOCIATES	
8" floppy controller (Pascal)	350

S-100 BOARDS

Assembled • Tested • Burned-in

CPU BOARDS		
Calif. Computer 2810A Z-80 DMA, 4MHz	BDC-C2810	$250
Godbout Z-80 24 bit, 4MHz	BDC-GZ80	239
Godbout 8085/8088 dual 16 bit processor	BDC-G88	375
Measurement Systems Z-80 4 serial 2 parallel real time clock, 8 vector	BDC-MZ80	395
SD Systems SBC-200 Z-80 with serial & parallel I/O ports	BDC-SBC2	385
Teletek FDC-1 single board CPU & floppy disk controller plus I/O	BDC-FDC1	695
MAINFRAMES		
Calif. Computer 2200A 12 slot & power supply	ENM-C2200	
TEI 12 slot table	ENM-T12	
TEI 22 slot table	ENM-T22	
Godbout mainfrm.	ENM-GMF	
MEMORY BOARDS		
Calif. Computer 2065A 64K dynamic memory	BDM-C2065	
Calif. Computer 2016 16K static memory	BDM-C2016	259
Calif. Computer 2032 32K static memory	BDM-C2032	585
Godbout Ram 17 64K static memory 16 bit	BDM-G17	1025
SD Systems Expandoram II 16K dynamic	BDM-EX16	295
64K dynamic	BDM-EX64	375
Measurement Systems DMB6400 for Alpha Micro	BDM-M6400	685
EPROM BOARDS		
Digital Research 32K, 2716 proms extra	BDM-DP32	99
SD Systems Prom-100 programmer	BDM-P100	250
FLOPPY DISK CONTROLLER		
Calif. Computer 2422A with 2.2 CPM	BDF-C2422	329
Godbout "Disk One" features the NEC 765 controller, DMA arbitration	BDF-GD1	395
Measurement Systems 765 chip, single & double density. Error recovery	BDF-MF	419
SD Systems Versafloppy II double density	BDF-VF2	419
Tarbell D/D	BDF-TF2	119
Morrow Design Disk Jockey I single density	BDF-DJ1	195
Morrow Design Disk Jockey II double density	BDF-DJ2	345
INTERFACE BOARDS		
Calif. Computer 2718 I/O 2 serial/2 par'l	BDT-C2718	
Morrow Designs Switchboard 2 serial/4 par'l	BDT-MSB	219
Morrow Designs Multiboard 3 serial/3P. ---	BDT-MMB	275
Godbout Interfacer One 2 serial/2 par'l	BDS-GE1	199
Godbout Interfacer Two 1 serial/3 par'l	BDS-GB2	199
SPECIALITY BOARDS		
QT Computer real time clock/calendar	BDS-QCK	135
Artec Elec. Wire wrap prototype board	BDS-AWW	25
Artec Elec. General Purpose proto board	BDS-AGP	25
Godbout Spectrum color board	BDS-GSC	205
D. C. Hayes S-100 Micromodem	BDS-HMI	350
Mullen Products extender board & logic probe kit	BDS-MTBI	49
Mullen Products Opto-contro board kit	BDS-MOC	139

Rotron Muffin Fan

$14.77 $12.00 @ 100
10.50 @ 1000

115 VAC. 7 Watts WR2A1
Factory fresh Muffin fans
NOT pull-outs. EMF-4M

VISA

master charge

All merchandise sold by California Digital is premium grade.
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FREE PLASTIC LIBRARY CASE INCLUDED WITH THE PURCHASE OF EVERY BOX OF DISKETTES

$24.95

Private labeled for California Digital by one of the most respected producers of magnetic media. Each diskette is certified double density at 40 tracks. To insure extended media life each diskette is manufactured with a reinforced hub-hole. And of course, a plastic library case is included with every box of diskettes. MMD-CD5(01)(10) Please specify computer or required sectors.

Ten boxes $22.75 One hundred boxes $21.50

5¼" DISKETTES WITH LIBRARY CASE

$26.50

Your Choice
SCOTCH
MEMOREX
VERBATIM

	Soft Sector	10 Sector	16 Sector	
SCOTCH	744-0	744-10	744-16	$26.50
MEMOREX	3401	3403	3405	26.50
VERBATIM	525-01	525-10	NA	26.50
DYSAN	104/1	107/1	NA	39.50

Single Side Double Density

DYSAN	104/1D	107/1D	NA	45.00

Double Side Double Density

SCOTCH	745-0	745-10	745-16	42.50
DYSAN	104/2D	107/2D	NA	49.50
DYSAN 96	204/2D	NA	NA	59.50

EIGHT INCH DISKETTES

Single Side Single Density

SCOTCH	740-0	29.50
MEMOREX	3060	29.50
DYSAN	3740/1	39.50

Thirty Two Sector

SCOTCH	740-32	29.50

Scotch Head Cleaning Kits 5¼ & 8"	$24.95
Plastic Library Cases 5¼ & 8"	2.95
Diskette Flip Tubs fifty diskettes 5¼"	24.95
Diskette Flip Tubs fifty diskettes 8"	29.95

Single Side Double Density

SCOTCH	741-0	39.00
MEMOREX	3090	35.00
DYSAN	3740/D	57.50

Double side Double Density

SCOTCH	743-0	47.50
MEMOREX	3114	39.50
DYSAN	3740/2D	65.00

PLEASE PHONE FOR VOLUME PRICING.

BSR SYSTEM X·10

The new BSR timer runs your home just like clockwork. Turns on lamps and appliances while your away from home. Completely compatible with your existing System X-10 devices.

BSR Timer eight channel	$65.00
Master control console	34.95
Ultrasonic Controller	19.95
Appliance Module 500 W.	$13.95
Lamp Module 300 Watts	13.95
NEW full control wall switch	14.50

WINCHESTER SUBSYSTEM

$1250

Includes seven megabyte Winchester hard disk, dual enclosure and power supply.
Floppy backup drive $199.00 additional.

MEMORY

64K DYNAMIC $9.95	16K STATIC $13.95
4164 100·	2167 70ns.
16K DYNAMIC $2.10	**2716 EPROM $4.95**
4116 100·$1.85	100·$4.50 1K·$4.00

2732 EPROM SALE $7.95

STATIC

		ea.	32+	100+	1K+
21L02	1K	1.19	1.09	1.05	.99
2114	300ns.	2.95	2.75	2.50	1.99
4044-4	450ns.	4.50	4.19	4.00	3.75
4044-2	250ns.	4.95	4.65	4.50	4.25
6116	16k 24 pin	7.95	7.50	6.75	5.45
2167/6167	20 pin	11.95	10.75	9.65	9.25

EPROM

2708	450ns.	3.95	3.50	3.25	3.00
2716	5V.	4.95	4.00	3.75	3.50
2716	tri-volt	8.50	7.95	7.65	7.25
2732	Intel/Hitac.	7.95	7.50	7.00	3.65
2532	Texas Inst	12.95	11.50	10.00	9.50
2764	64K Eprom	29.95	27.00	25.00	23.50

direct connect MODEM

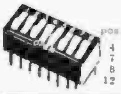
Your Choice **$169**

Direct connect modems eliminate loss of information due to the carbon compression associated with acoustic modems. Choose either of these two great units.

The Universal Data Systems 103LP is switch selectable between answer and originate modes. Fully Bell 103 compatable. Directly connects to the new modular telephone jack. 100% powered from the telephone line. No need to locate modem in proximity to A.C. power recepticle. MOD-103LP 2 pounds.

Novation "D" Cat connects to most of the new "Bell" modular handsets. Ideal for multiple line office telephones. Requires external A.C. power. MOD-DCAT 2 Lb.

SWITCHES



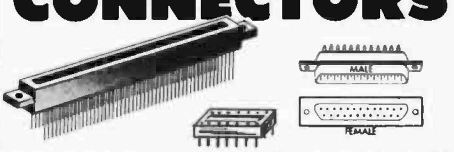
DIP SWITCHES

pos.	ea.	100+	1K+
4	.88	.75	.69
7	.99	.83	.79
8	1.05	.91	.87
12	1.19	.99	.91

TOGGLE

		ea.	100+
7101	on/on	1.19	.98
7103	on/off/on	1.39	1.19
7107	mnt. on	1.39	1.19
7108	mnt. on	1.39	1.19
7205	dpdt mnt	1.85	1.65

CONNECTORS



GOLD EDGE CONNECTORS

S-100 .125" centers	each	10+
Imsai solder .250" row	$2.95	$2.50
Imsai wire wrap (TI)	3.95	3.50
Sullins Hi-Rel. .250"	4.50	4.00
Sullins Hi-Rel. W/W	5.35	4.90
Sullins / Altair .140"	4.95	4.50
.156" Centers (standard)		
22/44 Kim Eyelet	2.50	2.15
36/72 Digital Group S/T	5.95	5.50
36/72 Digital Group W/W	6.60	6.15
43/86 Motorola 6800 S/T	6.60	6.15
43/86 Moto. 6800 W/W	7.00	6.85

INTEGRATED CIRCUIT SOCKETS

	Low Profile		Wire Wrap	
	each	100+	each	100+
8 pin	$.10	$.09	$.46	$.41
14 pin	.10	.09	.45	.41
16 pin	.12	.11	.50	.45
18 pin	.15	.13	.68	.61
24 pin	.26	.24	.94	.87
40 pin	.42	.40	1.60	1.47

"D" Type	each	10-24	25+
DE9P male	$1.60	$1.40	$1.30
DE9S female	2.25	2.00	1.90
DE hood	1.50	1.35	1.20
DA15P male	2.35	2.15	2.00
DA15S female	3.25	3.10	2.90
DA hood 2/P	1.60	1.35	1.30
DB25P male	2.50	2.35	2.25
DB25S female	3.35	3.15	3.05
DB hood 2/P	1.35	1.18	1.05
DC37P male	4.20	4.00	3.70
DC37S female	6.00	5.75	5.50
DC hood 2/P	2.25	2.00	1.75
DD50P male	5.50	5.10	4.75
DD50S female	9.40	8.60	8.00
DD50 hood 2/P	2.60	2.40	2.10
CENTRONICS			
57-30360	7.95	6.75	5.75
RIBBON CABLE CONNECTORS			
17/34 5" disk	4.95	4.15	3.95
20/40 TRS-80	5.65	5.05	4.70
25/50 8" disk	5.90	5.15	4.90

NEW OLIVETTI 801 Eight Inch Disk Drive $295

		ONE	TWO	TEN
★ OLIVETTI 801	single	$319	309	295
★ OLIVETTI 802/851	double	425	419	410
SHUGART 801/R	single	395	385	375
SHUGART 851/R	double	525	495	475
QUME DATA TRACK 8	double	525	495	475

★ The 8" Olivetti drives are aprox. ½" wider than the Shugarts.

Five Inch Disk Drives

OLIVETTI 501/400	single	199	185	175
OLIVETTI 502/451	double	235	225	215

Upon request, all drives are supplied with power connectors and one manual per order.

230 volt 50Hz. 8" add $50.00 per drive.

$995 ***Eight Inch Subsystem***

Two Olivetti 801 disk drives with power supply, 4" exhaust fan complete in dual enclosure with all necessary power cables. Documentation included. 50 Lbs. CAL-2801

Signal cable add $35.00 WCA-650D

Same as above but with:

Shugart 801R	MSD2801	$1195
Shugart 851R	MSD2851	1450
Olivetti 802	CAL2802	$1250
Qume DT8	MS08DT	1450

SPECIAL

$895

Volumn Pricing
Upon Request

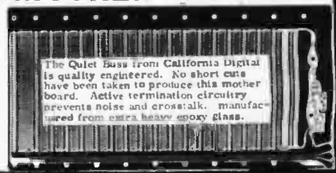
Seagate Compatable 7.5 MEGABYTE Winchester Hard Disk Drive

We have priced this so low that the manufacturer has asked not to use their brand name in our advertising.
Industry standard Seagate plug compatable. Drive fits into the same space as a 5¼" floppy disk drive. CAL-561/2

S-100 MOTHER BOARD

$35

IMSAI
18 Slot
CAL-M18



The Quiet Buss from California Digital is quality engineered. No short cuts have been taken to produce this mother board. Active termination circuitry prevents noise and crosstalk. manufactured from extra heavy epoxy glass.

VISA
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All merchandise sold by California Digital is premium grade.
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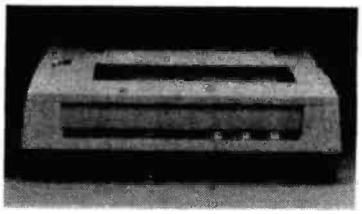
fast response, expert technical help, an

NEC-8023 A

High-resolution dot graphics. Proportional spacing. Correspondent quality printing. Bidirectional tractor and friction feed. 80, 136 col. Greek and math symbols. 100 cps matrix printer.

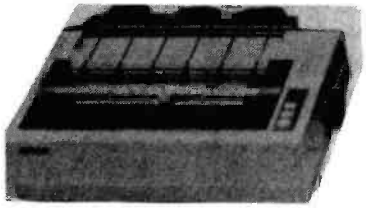
List $780 Parallel	$599



C. ITOH

Pro/Writer offers 8 character sizes, 5 different alphabets, and high proportional spacing, bidirectional, vert. and horiz. tabs, resolution graphics, nx9 matrix, 100 cps 136 col. max. Friction and tractor feed.

8510 Parallel	$549
8510 Serial	CALL



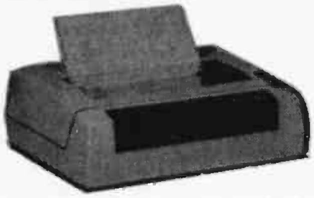
EPSON—COMPLETE STOCK!

Features disposable print heads. Graphtrax. All models except MX-70 print text in two directions. MX-80F/T and MX 100 have both friction and tractor feed. Unparalleled dot placement accuracy.

MX-70 (80 col.)	CALL
MX-80 (80 col.)	CALL
MX-80F/T (80 col.)	CALL
MX-100 (136 col.)	CALL
Interface Cards	CALL
Cables	CALL

VIDEO TERMINALS, MONITORS

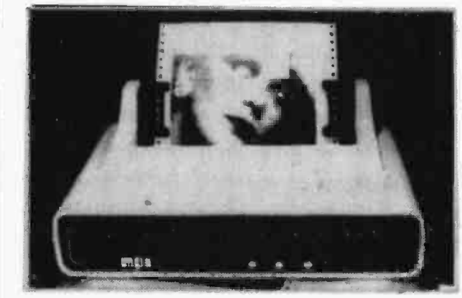
Ampex Dialog 80	$995
Ampex Dialog 30	$795
Televideo 920C	$845
Televideo 950	$995
SOROC IQ 120	$699
Zenith 12" Green	$119
NEC 12" Green	$169
Amdex 12" B/W (Leedex)	$99
Amdex 13" Color Lo-Res	$439



LOW, LOW PRICE ON NOVELL!

Heavy duty, 150 CPS, bidirectional, tractor feed, 9x9 dot matrix, 6 or 8 lines per inch, 10, 13.6 or 16.5 CPI, EIA RS-232C or parallel interface.-

IMAGE 800	$995



MPI 88G/99G MATRIX

High resolution dot-addressable graphics for Apple. Enhanced "correspondence quality" printing. Tractor and friction feed. Serial and Parallel Input. 100 cps Bi-directional printing.

88 G (132 col.) List $749	$549
99 G (132 col.) List $849	$599
Apple parallel I/O Card/Cable/Disk	$110
with Graphics Prom (Ap-Pak)	$145
IEEE I/O Card	$55
Single Sheet Feeder	$25
QT Cover	$30

OKIDATA
UP TO 200 CPS!

Microline 82A—*80/132 col., 120 CPS, 9x9 dot matrix, friction, pin feed or tractor feed (removeable) rear and bottom feed. Includes bi-directional/logic seeking, serial and parallel interfaces. Double width and condensed characters, true lower case descenders and graphics.*

82A	$545

Microline 83A—*132/232 col., 120 CPS, handles forms up to 15 in. wide, plus all the features of the 82A.*

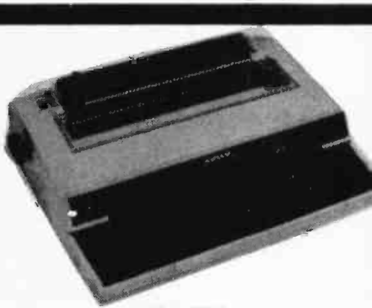
83A	$775

Mircroline 84SP—*132/232 col., 200 CPS, with full dot graphics built-in. Takes forms up to 15 in. wide, plus all the features of the 83A.*

84SP	$1250

MODEMS

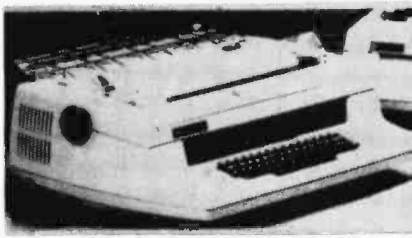
UDS-103 LP, *direct*	$175
03 JLP *Auto Answer*	$209
202 LP *1200 BAUD*	$259
NOVATION-CAT, *acoustic*	$145
D-CAT, *direct*	$155
Auto Cat	$219
Apple Cat	$329
HAYES-S100 Micromodem	$349
Apple Micromodem	$299
Smart Modem	$245



ADLER

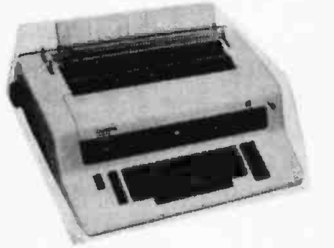
17.5 CPI, 10, 12, 15 and proportional spacin line correcting memory, inter-changeable p wheels.

SE1010 List $1295	SAVE $3
Interface Card	ADD $3



NEC SPINWRITERS

7710/7730 RO w/tractor	$25
7720 KSR w/tractor	$29
3510/3530 RO	$17
Bidirectional tractor	$2
Push tractor	$3



OLYMPIA

Letter quality. Daisy wheel printer typewr interfaces to Apple, Atari, NEC, TRS80 a RS232 Serial ports.

ES 100KRO Computer printer List $1690	SAVE $3
ES 100 Typewriter only List $1195	SAVE $2
Interface Card Only (specify serial or parallel)	$2
I/O Cable (specify serial or parallel)	$
Apple Serial Card	$1

MODEMS

BIZCOMP *Super low introductory price. S over other modems! Apple—direct connec game port. No serial card needed. Save $1 more. Atari—direct connect via inte module and telelink cartridge. Commodo the only modem available. Each pkg. con cable with connectors and phone T-adapt*

Apple Comm Pkg	$1
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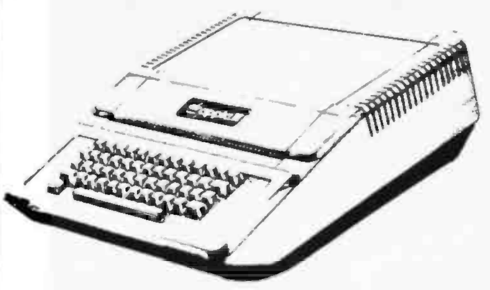

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16K RAMcard	$158.99

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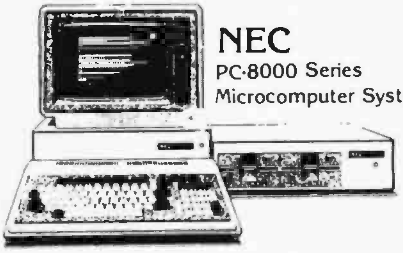

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Apple II 64K w/Z80 Softcard & Vision 80	2519 00	1775 00
★ Apple III 128K	3495 00	★ 2895 00

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Prototype Card	24 00	21 95
IEEE-488 Interface	450 00	375 00
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Applesoft II ROM Card	200 00	159 95
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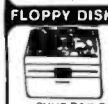

Qume Only $569.95

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PERSCI Model 277 Dual	1195 00
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- Apple II compatible

List $195.00 ACP $74.95

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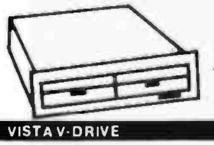
★ Vision 80 © 80x24 display card	$395 00	$299 00
Vision 40 © 40 col enhancement	199 00	149 00
Vision 20 © lower case ROM	29 95	25 00
★ A800 Double Density 8" Controllers	595 00	★ 499 00
MM9 9 voice music	195 00	99 00
GB/5 IBM Regent/Apple I/O	195 00	169 00
PDS PROM development	595 00	399 00
TYPE AHEAD BUFFER	49 95	35 00



Vision 80

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VISTA V-DRIVE
Model V-1000 8" floppy disk enclosures with Qume Datatrak 8

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V 80 Dual drive, case, ps		$589 00

D S D/D also available

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A2C controller	100 00	89 00
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[illegible]	Soft Sectored TRS [illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

- 40 TRACKS DOUBLE SIDED DOUBLE DENSITY 5¼

[illegible]	[illegible]	$39 95
[illegible]	[illegible]	$39 95
[illegible]	[illegible]	$39 95

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[illegible]	Soft Single Density [illegible]	[illegible]
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[illegible]	Soft Double Sided [illegible] Density 1/40	[illegible]

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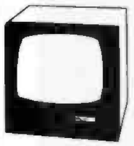

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(Sanyo Look Alike)

Model Pi 1 9" Green	$159.95
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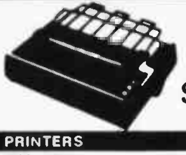

$429.00

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		LIST	ACP
MX-80 Dot Matrix		$645 00	★ $429 00
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Serial I/O & cable		130 00	95 00
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8023 Dot Matrix		795 00	649 00
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8510	100 cps	749 00	★ 675 00
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IDS			
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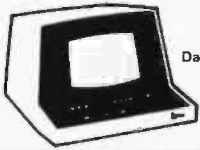

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950C	1195 00	999 00
SOROC		
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IQ135		899 00
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SANYO

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	LIST	ACP
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12" B&W	340 00	249 00
12" Green	360 00	279 00
13" Color	550 00	479 00
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Novation

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D Cat	199 95	169 00
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Auto-Cat	299 95	239 95
HAYES		
Micromodem	$379 00	$299 00
Smartmodem	279 00	249 00

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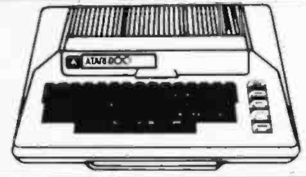
IBM Extender Board	19 95



ATARI®

ATARI COMPUTER

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825 Printer	799 95	699 00
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MTK 16K RAM	99 50	74 00
MTK 32K RAM	199 50	139 00
ATARI VisiCalc	200 00	160 00
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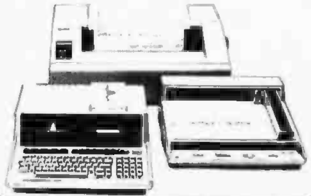

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HP-38C Prog Business		150 00	119 00
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Drives 2 Drives
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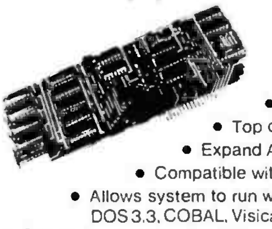

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2 or 4 MHz
Expandable
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BARE BOARDS

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for COLOR & B/W

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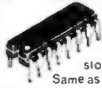
MOSTEK 4K RAMS



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Gain = 40V/mV
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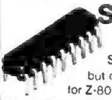

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Same as TMS4044 but designed specifically for Z-80 based systems. This is a full-spec 4Kx1 RAM, 450nS. Order P/N Zilog 6104-4 while supply lasts.

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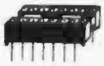

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14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.29	.27	.24
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
40 pin LP	.60	.59	.58

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14 pin WW	.75	.73	.67
16 pin WW	.80	.77	.70
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LM741CN/H	.33	SN75453N	.49
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74S05	.52	74S136	1.69	74S258	1.29
74S08	.49	74S138	1.29	74S260	.75
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74S11	.42	74S151	1.29	74S288	2.55
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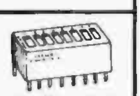

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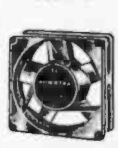

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7407	.35	7486	.35	74170	1.69
7408	.26	7489	1.75	74172	4.75
7409	.23	7490	.39	74173	.79
7410	.22	7491	.57	74174	.89
7411	.29	7492	.45	74175	.85
7412	.29	7493	.45	74176	.75
7413	.39	7494	.69	74177	.75
7414	.59	7495	.65	74179	1.34
7416	.29	7496	.69	74180	.75
7417	.29	7497	2.90	74181	1.75
7420	.22	74100	2.90	74182	.75
7421	.35	74107	.32	74184	2.25
7422	.29	74109	.37	74185	2.25
7423	.29	74116	1.95	74186	9.95
7425	.29	74121	.29	74188	3.90
7426	.29	74122	.39	74190	1.15
7427	.25	74123	.59	74191	1.15
7429	.45	74125	.39	74192	.85
7430	.23	74126	.44	74193	.85
7432	.29	74128	.59	74194	.85
7437	.25	74132	.69	74195	.68
7438	.29	74136	.75	74196	.85
7439	.29	74139	.95	74197	.85
7440	.19	74141	.79	74198	1.39
7441	.79	74142	2.95	74199	1.39
7442	.57	74143	2.95	74221	1.19
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7451	.19	74153	.67	74290	1.25
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7454	.19	74155	.78	74365	.68
7459	.25	74156	.78	74366	.68
7460	.23	74157	.69	74367	.68
7470	.29	74158	1.65	74368	.68
7472	.29	74159	2.49	74390	1.45
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74LS04	.35	74LS124	1.35	74LS251	1.40
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74LS28	.33	74LS158	.75	74LS298	1.19
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74LS38	.39	74LS164	1.19	74LS353	1.19
74LS40	.26	74LS165	.89	74LS363	1.49
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74LS47	.79	74LS168	1.15	74LS366	.69
74LS48	.95	74LS169	1.15	74LS367	.69
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74LS54	.29	74LS173	.89	74LS373	1.89
74LS55	.29	74LS174	.89	74LS374	1.89
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4021	1.19	4066	.75	4510	1.19
4022	1.15	4069	.35	4511	1.19
4023	.29	4070	.49	4512	1.39
4024	.75	4071	.35	4515	2.75
4025	.25	4072	.35	4516	1.45
4027	.65	4073	.35	4518	1.39
4028	.85	4075	.35	4520	1.25
4029	1.29	4076	1.29	4555	4.95
4030	.45	4077	.35	4556	.99
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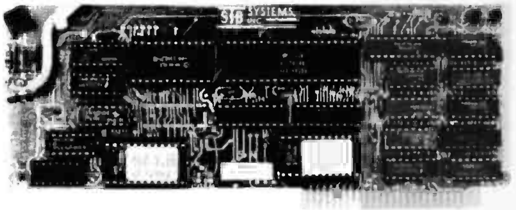

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FEATURES:

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- ★ Software Screen Switch to Standard Apple
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- ★ Compatible with PASCAL & CP/M
- ★ Software Controllable Inverse Video by Character & Screen

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This patches the APPLE EDITOR & ASSEMBLER for use with the STB-80.
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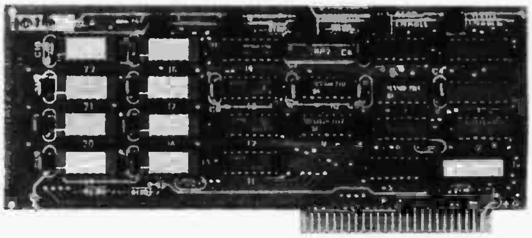

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- ★ Assembled and Tested
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- ★ DOS 3.3 Support Disk FREE with Purchase

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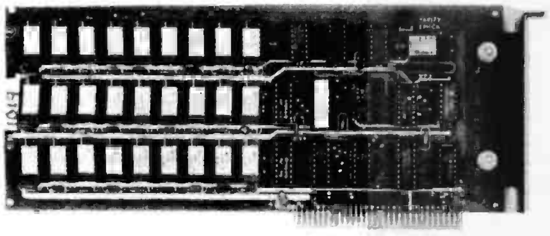

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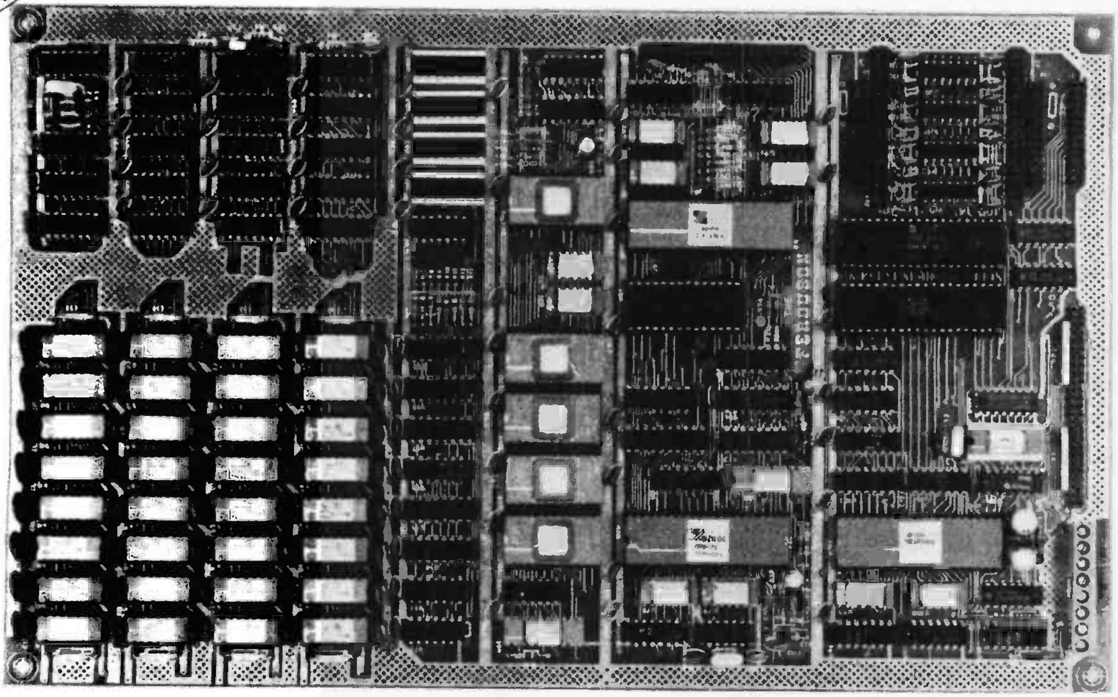

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Full Documentation and
Schematics — $5.

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THE BIG BOARD PROJECT: Three years in the works, and maybe too good to be true. A tribute to hard headed, no compromise, high performance, American engineering! The Big Board gives you all the most needed computing features on one board at a very reasonable cost. The Big Board was designed from scratch to run the latest version of CP/M*. Just imagine all the off-the-shelf software that can be run on the Big Board without any modifications needed! Take a Big Board, add a couple of 8 inch disc drives, power supply, an enclosure, C.R.T., and you have a total Business System for about 1/3 the cost you might expect to pay.

$399.00 ** (64K KIT BASIC I/0)

SIZE: 8½ x 13¾ IN.
SAME AS AN 8 IN. DRIVE.
REQUIRES: +5V @ 3 AMPS
+ - 12V @ .5 AMPS.

FULLY SOCKETED!

FEATURES: (Remember, all this on one board!)

64K RAM

Uses industry standard 4116 RAM'S. All 64K is available to the user, our VIDEO and EPROM sections do not make holes in system RAM. Also, very special care was taken in the RAM array PC layout to eliminate potential noise and glitches.

Z-80 CPU

Running at 2.5 MHZ. Handles all 4116 RAM refresh and supports Mode 2 INTERUPTS. Fully buffered and runs 8080 software.

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Full 2 channels using the Z80 SIO and the SMC 8116 Baud Rate Generator. FULL RS232! For synchronous or asynchronous communication. In synchronous mode, the clocks can be transmitted or received by a modem. Both channels can be set up for either data-communication or data-terminals. Supports mode 2 Int. Price for all parts and connectors: $49

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24 x 80 CHARACTER VIDEO

With a crisp, flicker-free display that looks extremely sharp even on small monitors. Hardware scroll and full cursor control. Composite video or split video and sync. Character set is supplied on a 2716 style ROM, making customized fonts easy. Sync pulses can be any desired length or polarity. Video may be inverted or true. 5 x 7 Matrix - Upper & Lower Case

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TERMS: Shipments will be made approximately 3 to 6 weeks after we receive your order. VISA, MC, cash accepted. We will accept COD's (for the Big Board only) with a $75 deposit. Balance UPS COD. Add $4.00 shipping.

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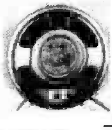
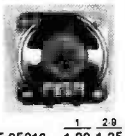
SPEAKERS





Part#	1	2-9
A0201	1.25	.99
SF-25016	1.39	1.25

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.25 Watt (4" Leads)
Size: 2¼" x ¾"

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- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
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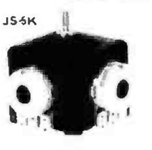

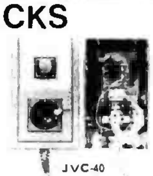

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General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

FEATURES:
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- Power Output (each supply): 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
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- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 3-1/2"w x 5-1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) .. $24.95
(Picture not shown but similar in construction to above)
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MICROPROCESSOR COMPONENTS

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DP8224	Clock Generator/Driver	2.95
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DP8238	System Controller	5.95
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DP8255	Prog. Peripheral I/O (PPI)	5.95
DP8257	Prog. DMA Control	9.95
DP8259	Prog. Interrupt Control	9.95
DP8275	Prog. CRT Controller	39.95
DP8279	Prog. Keyboard/Display Interface	9.95
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DP8310	Octal Latched Peripheral Driver	5.25
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6800/6800 SUPPORT DEVICES

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MC6828	Priority Interrupt Controller	17.95
MC6830L8	1024x8-Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
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CDP1802	CPU	19.95
2650	MPU	16.95
IDM2901ADC	CPU—4-Bit Slice (Com. Temp. Grade)	19.95
MCS6502	MPU w/Clock (65K Bytes Memory)	11.95
INS8035N-6	MPU—8-Bit (6MHz)	7.95
INS8039N-6	CPU—Sgl. Chip 8-Bit (128bytes RAM)	9.95
INS8040N-6	CPU (256 Bytes RAM)	24.95
INS8070N	CPU—64 Bytes RAM	24.95
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TMS9900JL	MPU—16-Bit	39.95

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MM503H	Dual 50-Bit Dynamic	.50
MM506H	Dual 100-Bit Static	.50
MM510H	Dual 64-Bit Accumulator	.50
MM1402N	256-Bit Dynamic	2.95
MM5013N	1024-Bit Dynamic/Accumulator	1.95
MM5016N	500/512-Bit Dynamic	1.95
MM5034N	Octal 80-Bit	9.95
MM5035N	Octal 80-Bit	9.95
2504V(1404A)	1024-Bit Dynamic	1.95
2518N	Hex 32-Bit Static	3.95
2522V	Dual 132-Bit Static	2.95
2524V	512-Bit Dynamic	.99
3341PC	Fifo (Dual 80)	6.95

DATA ACQUISITION

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MC1408L8	8-Bit D/A Converter (DAC0808LCN)	5.75
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AF122-1CJ	Touch Tone High Band Filter	19.95
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LM334Z	Constant Current Source	1.30
LM335Z	Temperature Transducer	1.40
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LF398N	Sample & Hold Amplifiers	3.95
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ADC0817CCN	8-Bit A/D Converter (16-Ch. Multi.)	10.95
DAC1000LCN	10-Bit D/A Conv. Micro. Comp. (0.05%)	13.95
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DAC1222LCN	12-Bit D/A Converter (0.20% Lin.)	9.95
CD4051N	8-Channel Multiplexer	1.19
AY-5-1013	30K BAUD UART	6.95

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Part	Description	Price
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1103	1024x1 Dynamic	.99
2101 (8101)	256x4 Static	3.95
2102	1024x1 Static	1.75
21L02	1024x1 Static	1.95
2111 (8111)	256x4 Static	3.95
2112	256x4 Static MOS	4.95
2114	1024x4 Static 450ns	2.25
2114L	1024x4 Static 450ns Low Power	2.49
2114-2	1024x4 Static 200ns	2.49
2114L-2	1024x4 Static 200ns Low Power	2.95
74S200	256x1 Static	6.95
4116N-4 (UPD416)	16K Dynamic 250ns (MM5290N-4)	1.95
4164N-3	64K Dynamic 200ns	14.95
MM2147N	4096x1 Fast 70ns	4.95
5101	256x4 Static	7.95
MM5261	1024x1 Dynamic Fully Decoded	.99
MM5262	2Kx1 Dynamic	.49
MM5280/2107	4096x1 Dynamic	4.95
MM5290N-2 (4116)	16K Dynamic 150ns (UPD416C-3)	2.95
MM5298J-3A	8K Dyn. 200ns (lower ½ of MM5290J)	1.95
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UPD414/MK4027	4K Dynamic 16-pin	4.35
TMS4044-45NL	4K Static	9.95
TMS4045	1024x4 Static	9.95

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Part	Description	Price
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2708	8K EPROM	2.95
TMS2716	16K EPROM (-5V, +5V, +12V)	9.95
2716Intel(2536)TI	16K EPROM (Single +5V)	8.95
2732Intel TI	32K EPROM	17.55
2758	8K EPROM (450ns) (Single +5V)	7.49
2764Q	64K EPROM (Hitachi HN462764)	49.95
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82S23(74S188)	32x8 PROM (Open Collector)	3.95
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82S185	8K PROM	16.95

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Part	Description	Price
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Part	Description	Price
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MCM66740P	128x9x7 Math Symbol & Pictures	13.50
MCM66750P	128x9x7 Alpha. Control Char. Gen.	13.50

MICROPROCESSOR MANUALS

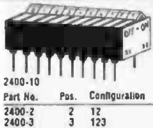
Part	Description	Price
M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

SPECIAL FUNCTION

Part	Description	Price
DS0025CN	Dual MOS Clock Driver (5MZ)	3.50
DS0026CN	Dual MOS Clock Driver (5MZ)	1.95
INS1771N-1	Floppy Disc Controller	24.95
INS2651N	Communication Chip	19.95
MM58167N	Microprocessor Real Time Clock	8.95
MM58174N	Microprocessor Compatible Clock	11.95
COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
COP402MN	Microcontroller with 64-Digit RAM & Direct LED Drive w/N Buss Int.	7.49
COP470N	32-Seg. VAC Fluor. Driver (20-pin pkg.)	3.25

TELEPHONE/KEYBOARD CHIPS

Part	Description	Price
AY-5-9100	Push Button Telephone Dialer	14.95
AY-5-9200	Repertory Dialer	14.95
AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	11.95
HD0165-5	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.49
74C923	Keyboard Encoder (20 keys)	5.75
MM53190N	Push Button Pulse Dialer	7.95
MM57499N	96/144-Key Serial Keyboard Encoder	8.95



2400-10

EECO Rocker DIP Switch — "Mini-Dip™" 2400 Series
THE MOST UNIQUE DIP SWITCH AVAILABLE!

MINI-DIP is designed to retrofit all major brands of Dip switches. Unique features include locking rod design to prevent accidental actuation and gold self-wiping contact. One-piece housing and press-fit terminals prevent contamination. 2-10 station Form "A" and 1-5 station Form "C." • Terminals on .100 x .300 (2.54 x 7.62) centers • PCB or dip socket mountable • Positive cleaning/wiping action with gold contact • Total seal and bottom seal

Part No.	Pos.	Configuration	Socket	Price	Part No.	Pos.	Configuration	Socket	Price
2400-2	2	12	8 pin	.79 · 10/ 8.95	2400-6	6	123456	14 pin	1.09 · 10/ 9.95
2400-3	3	123	8 pin	.89 · 10/ 7.95	2400-7	7	1234567	14 pin	1.19 · 10/10.95
2400-4	4	1234	8 pin	.99 · 10/ 8.95	2400-8	8	12345678	16 pin	1.29 · 10/11.95
2400-ABCD	4	ABCD	8 pin	.99 · 10/ 8.95	2400-9	9	123456789	18 pin	1.39 · 10/12.95
2400-5C	6	C54321	14 pin	1.09 · 10/ 9.95	2400-10	10	0123456789	20 pin	1.49 · 10/13.95

GRAB BAG SPECIALS

GB180 100 pieces Robot/Slot Car Gears, Shafts, Wheels, Motors $9.95

CAPACITORS

Part No.	Description	Price
GB100	100 each Ceramic Disc (10pf—.1mf)	$2.00
GB101	60 each Mylar	4.00
GB102	60 each Electrolytics	4.00
GB103	40 each Tantalum (tubular & dipped)	4.00
GB176	40 each Dipped Silver (10pf-1000pf @ 100-500V)	4.00

INTEGRATED CIRCUITS

Part No.	Description	Price
GB106	60 each TTL Series — marked (7400, 74107, 74123, etc.)	$4.00
GB109	30 each Linear — marked (LM301, 307, 741, 308, etc.)	4.00
GB148	30 each Exar — marked (XR320, 1310, 4136, etc.)	4.00
GB150	20 each Shift Registers — marked (2510, 2518, 2532, 2533, etc.)	4.00
GB157	50 each DTL Series — marked (DM930, 932, 936, 946, etc.)	3.00
GB158	8 pcs. Positive Voltage Regulators (TO-3 case) (7805, 06, 12, 15, 18, 24, etc.) Linear marked	4.25
GB159	8 pcs. Negative Voltage Regulators (TO-3 case) (7905, 06, 12, 15, 18, 24, etc.) Linear marked	4.00
GB170	25 each Assorted 74LS TTL Series	4.00
GB172	10 pcs. 78M Positive Volt. Reg. (TO-5 case) (78M05, 6, 12, 15, 20, 24, etc.) Linear marked	5.00

LEDS – LAMPS – READOUTS

Part No.	Description	Price
GB110	100 each Assorted LEDs (colors & sizes) (XC556, XC526, etc.)	$4.00
GB111	40 each NE-2 Neon Type Lamps	3.00
GB112	20 ea. Multiple Readouts, calculators, watches, timers, LEDS to Panaplex — new, used and rejects	4.00
GB162	50 each 7 Segment Displays (various colors and sizes)	5.00

POTENTIOMETERS

Part No.	Description	Price
GB113	30 each Miniature Trimmers (100 ohm-1 Meg)	$4.00
GB134	24 each 3/8" square single turn PC Mount (untested — 10 ohm to 500 ohm) marked	3.00
GB135	24 each 3/8" square single turn PC Mount (untested — 1K to 50K) marked	3.00
GB136	24 each 3/8" square single-turn PC Mount (untested — 100K to 5 Meg) marked	3.00
GB173	100 ea. 3/8" sq. single turn (U Test & Sort)	6.00
GB174	25 ea. ½ watt thumbwheel single-turn (500 ohm-5 Meg)	2.00

DIODES

Part No.	Description	Price
GB171	80 each Assorted Germanium (1N34, 1N68, 1N270)	$2.00
GB107	100 each Silicon (1N914/1N4148)	2.00
GB164	200 each marked, unmarked rectifiers & zeners	2.00
GB178	100 ea. 1 amp., 3 amp (cathode band) silicon rectifiers	3.00

RESISTORS

Part No.	Description	Price
GB116	200 each 1/4 watt resistor assortment	$2.00
GB117	200 each 1/2 watt resistor assortment	2.00
GB118	30 ea. Wire Wound 5,10,20W 1Ω-100 ohm	4.00
GB154	100 each 1 and 2 watt resistor assortment	2.00
GB178	500 each 1/8, 1/2, 1 watt (marked/unmarked) resistors	4.00

SWITCHES

Part No.	Description	Price
GB120	25 each Miniature slide	$3.00
GB122	20 ea. Reed relays with coil and magnet — glass tube	5.00
GB165	40 asst. toggle, rocker, pushbutton	10.00
GB179	20 each Dip Switches (asst. positions)	8.95

HARDWARE

Part No.	Description	Price
GB139	40 each Terminal Strips solder and screw types (3 to 8 terminals)	$3.00
GB140	150 each Spacers, standoff, insulators (metal, nylon and plastic)	2.00
GB141	200 each Washers and Spacers (nylon and teflon)	2.00
GB142	50 ea. Chassis mounting feet (rubber and plastic)	2.00
GB144	200 each Solder lugs (small)	2.00
GB145	100 each Lugs — crimp on (some insulated)	2.00
GB146	100 each Grommets, cord strain reliefs and hole plugs	3.00
GB147	500 each Hardware mix (nuts, bolts, screws, lugs)	5.00
GB166	48 Threaded metal and plastic spacers (½-2" long)	2.00
GB167	200 pcs. sheet metal and metal tapping screws	2.00
GB168	200 pcs. angle bolt, clip insulators, etc.	3.00
GB169	100 pcs. tie wraps and harness clips (3-8")	3.00
GB180	100 pcs. Robot/Slot Car gears, shafts, wheels, motors	8.95

MISCELLANEOUS

Part No.	Description	Price
GB123	30 each Heat Sinks — assorted sizes	$3.00
GB124	8 each assorted calculator type keyboards	5.00
GB126	50 each Opto-Isolators — (IL-1 Series (untested)	2.00
GB127	100 each Transistors — plastic and power	3.00
GB128	30 each Toroid Cores — iron and tape	4.00
GB129	50 each Photo Transistors (LPT)	4.00
GB130	1 each Tape Drive — 6V motor with read/write erase head and 2 cassette tapes (no amplifier)	5.00
GB131	30 each 6" shrink tubing, asst. sizes and colors	4.00
GB137	50 each Chokes, coils and inductors (molded wire adjustable)	3.00
GB738	2 each Speakers, 2½", 8 ohm, 1/4 watt	1.95
GB155	300 each mixed resistors, capacitors diodes, transistors, chokes	3.00
GB160	Printed Circuit Board Contains 50-75 components on each board	2.00
GB163	30 ea. Sockets (Asst. IC and transistor)	4.00
GB177	200 each 1" Shrink tubing, asst. colors and sizes	3.00

$10.00 Minimum Order — U.S. Funds Only
California Residents Add 6% Sales Tax
Postage — Add 5% plus $1.50 Insurance
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6/82

BOOKS
National Semiconductor — Intersil — Intel

No.	Title	Price
30001	National CMOS Data Book (640 pages) 74C, CD4000, and A/D Converters	$6.95
30002	National Interface Data Book (704 pages) DP, DS8000, DS3600, DS75000, etc.	$6.95
30003	National Linear Data Book (1376 pages) LM, LF, ADC, DAC, LH Series	$11.95
30004	National Series 80 — Board Level Computer (224 pages)	$4.95
30005	National TTL Logic Data Book (624 pages) 7400,LS,L,H,S, and DM8000 Series	$8.95

30006 Above (3) 30001,3,5 as set $24.95/lot

No.	Title	Price
010400	Intel Component Data Catalog — Full data sheets for Intel's products incl. memory devices, microproc., peripherals & indust./mil. products (1328 pages)	$14.95
205610	Intel Peripheral Design Handbook — Full data sheets, appl. notes for Intel peripheral device components (644 pages)	$9.95

AC and DC Wall Transformers

With Universal Plug and 9V Battery Snap

Selective voltages, 6,9,12VDC. Polarity selection (+/-). Six-foot line from adapter to plugs — six-inch line from adapter to battery snap. 120V/60Hz. 300mA.

Part No.	Input	Output	Price
AC 250	117V/60Hz	12VAC 250mA	$3.95
AC 500	117V/60Hz	12VAC 500mA	$4.95
AC1000	117V/60Hz	12VAC 1 amp	$5.95
AC1700	117V/60Hz	9VAC 1.7 amp	$3.95
DC 800	120V/60Hz	8VDC 400mA (batt. charger)	$1.95
DC6912 (above)	120V/60Hz	6,9,12VDC 300mA	$9.95
DV9200	117V/60Hz	9VDC 200mA	$3.25
DC900	120V/60Hz	9VDC 500mA	$3.95
DC1200	120V/60Hz	12VDC 300mA	$2.95

CONNECTORS

Part	Description	Price
DB25P	D-Subminiature Plug	$2.95
DB25S	D-Subminiature Socket	$3.50
D20418-2	Screw Lock Hdwr. (2) DB25S/P	2/$.99
DB51226	Cover for DB25P/S	$1.75
22/44SE	P.C. Edge (22/44 Pin)	$2.95
UG88/U	BNC Plug	$1.79
UG89/U	BNC Jack	$3.79
UG175/U	UHF Adapter	$ .49
SO239	UHF Panel Recp.	$1.29
PL258	UHF Adapter	$1.60
PL259	UHF Plug	$1.60
UG260/U	BNC Plug	$1.79
UG1094/U	BNC Bulkhead Recp.	$1.29

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K
Kit comes complete with:
- 8 ea. MM5290 (UPD416/4116) 16K Dyn. Ram (*ns)
- Documentation for conversion

Part	Speed	Price
TRS-16K2	*150ns	19.95
TRS-16K3	*200ns	16.95
TRS-16K4	*250ns	14.95

KEYBOARDS

Datanetics 74-Key Keyboard

Uses EA 20134 Chip (Electronic Arrays). Size: 16⅜"L x 5½"W x 1-3/8"H. White, black, blue, grey key caps. (No Data Sheet) —

Part No. KB354 .... $29.95 ea.

Micro Switch 69-Key Keyboard

Uses AMI SW20350K Chip. Size: 16-3/8"L x 5¼"W x 1-5/8"H Metal Frame. Light & dark grey key caps (No Data Sheet)

Part No. KB69SD12-2 .... $19.95 ea.

Boschert Multi-Voltage Power Supply
5VDC, 12VDC and 24VDC

FEATURES: Voltages*: 5VDC @ 25amps, 12VDC @ 4amps, & 24VDC @ 4amps. Reg. Load: +5V out ±1%, +12 & 24V out ±5% (20-100% load). Overvolt. & overcurr. protection. 115 or 230VAC input. Wt. 4 lbs. Size: 4.95" x 2.50" x 15.00"
*Total average output shall not exceed 200 watts.

General Description: The "Boschert" Power Supply was originally designed for application with ITT Advance Terminal Controller (ATC). This open frame switching power supply provides user with high current requirements common in use with computer systems. Its compact size provides versatility for mounting into electronic enclosures. Each supply has 6 threaded fasteners (pem nut type) for mounting. Specification requirements to be used with ATC enclosed.

Part No. 200-3010 .... $69.95 each

— MANY OTHERS AVAILABLE • WRITE FOR INFORMATION —

JE600 Hexadecimal Encoder Kit

FULL 8-BIT
LATCHED OUTPUT
19-KEY KEYBOARD

The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¼"W x 8¾"D

JE600/DTE-HK (After assembled as pictured above) **$99.95**

JE600 Kit 19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case) .. **$59.95**

K19 19-Key Keyboard (Keyboard only) **$14.95**

DTE-HK (case only — 3½"Hx8¼"Wx8¾"D) **$44.95**

Circle 248 on inquiry card.

7400

SN7400N	.20	SN7472N	.29	SN74156N	.79
SN7401N	.20	SN7473N	.35	SN74157N	.69
SN7402N	.25	SN7474N	.35	SN74160N	.89
SN7403N	.25	SN7475N	.49	SN74161N	.89
SN7404N	.25	SN7476N	.35	SN74162N	.89
SN7405N	.29	SN7479N	5.00	SN74163N	.89
SN7406N	.35	SN7480N	.50	SN74164N	.89
SN7407N	.35	SN7482N	.99	SN74165N	.89
SN7408N	.29	SN7483N	.69	SN74166N	1.25
SN7409N	.29	SN7485N	.89	SN74167N	2.79
SN7410N	.25	SN7486N	.35	SN74170N	1.95
SN7411N	.29	SN7489N	1.75	SN74172N	4.95
SN7412N	.35	SN7490N	.49	SN74173N	1.39
SN7413N	.40	SN7491N	.59	SN74174N	.99
SN7414N	.69	SN7492N	.45	SN74175N	.89
SN7416N	.29	SN7493N	.45	SN74176N	.79
SN7417N	.29	SN7494N	.69	SN74177N	.79
SN7420N	.25	SN7495N	.69	SN74179N	1.49
SN7421N	.29	SN7496N	.69	SN74180N	.79
SN7422N	.45	SN7497N	3.00	SN74181N	2.25
SN7423N	.29	SN74100N	1.49	SN74182N	.79
SN7425N	.29	SN74104N	.89	SN74184N	2.49
SN7426N	.29	SN74105N	.89	SN74185N	2.49
SN7427N	.25	SN74107N	.35	SN74190N	1.25
SN7428N	.49	SN74109N	.39	SN74191N	1.25
SN7430N	.25	SN74116N	1.95	SN74192N	.89
SN7432N	.29	SN74121N	.39	SN74193N	.89
SN7437N	.25	SN74122N	.55	SN74194N	.89
SN7438N	.40	SN74123N	.59	SN74195N	.69
SN7439N	.25	SN74125N	.49	SN74196N	.89
SN7440N	.20	SN74126N	.49	SN74197N	.89
SN7441N	.89	SN74132N	.75	SN74198N	1.49
SN7442N	.59	SN74136N	.75	SN74199N	1.49
SN7443N	1.10	SN74141N	.99	SN74221N	1.25
SN7444N	1.10	SN74142N	3.25	SN74251N	.99
SN7445N	.89	SN74143N	3.49	SN74276N	1.95
SN7446N	.79	SN74144N	3.49	SN74279N	.79
SN7447N	.69	SN74145N	.79	SN74283N	1.49
SN7448N	.79	SN74147N	1.95	SN74284N	3.95
SN7450N	.20	SN74148N	1.29	SN74285N	3.95
SN7451N	.20	SN74150N	1.25	SN74365N	.69
SN7453N	.20	SN74151N	.69	SN74366N	.69
SN7454N	.20	SN74152N	.69	SN74367N	.69
SN7459A	.25	SN74153N	.79	SN74368N	.69
SN7460N	.20	SN74154N	1.25	SN74390N	1.49
SN7470N	.29	SN74155N	.79	SN74393N	1.49

74LS

74LS00	.29			74LS192	1.15
74LS01	.29			74LS193	1.15
74LS02	.29	74LS92	.75	74LS194	1.15
74LS03	.29	74LS93	.75	74LS195	1.15
74LS04	.35	74LS95	.99	74LS197	1.19
74LS05	.35	74LS96	1.15	74LS221	1.19
74LS08	.35	74LS107	.45	74LS240	1.49
74LS09	.35	74LS109	.45	74LS241	1.49
74LS10	.35	74LS112	.45	74LS242	1.49
74LS11	.39	74LS113	.49	74LS243	1.49
74LS12	.35	74LS114	.49	74LS244	1.49
74LS13	.59	74LS122	.89	74LS245	2.95
74LS14	.99	74LS123	1.25	74LS247	1.19
74LS15	.35	74LS125	.59	74LS248	1.19
74LS20	.35	74LS126	.59	74LS249	1.19
74LS21	.35	74LS132	.99	74LS251	.99
74LS22	.35	74LS133	.89	74LS253	.99
74LS26	.35	74LS136	.49	74LS257	.89
74LS27	.35	74LS138	.89	74LS258	.69
74LS28	.35	74LS139	.89	74LS260	.69
74LS30	.35	74LS151	.89	74LS266	.69
74LS32	.35	74LS153	.89	74LS273	1.95
74LS33	.59	74LS154	1.75	74LS279	.89
74LS37	.45	74LS155	.89	74LS283	.89
74LS38	.39	74LS156	.89	74LS290	.99
74LS40	.35	74LS157	.89	74LS293	.99
74LS42	.89	74LS158	.89	74LS298	1.25
74LS47	.69	74LS160	1.15	74LS352	1.29
74LS48	1.15	74LS161	1.15	74LS353	1.29
74LS49	1.15	74LS162	1.15	74LS365	.69
74LS51	.35	74LS163	1.15	74LS366	.69
74LS54	.35	74LS164	1.15	74LS367	.69
74LS55	.35	74LS165	1.15	74LS368	.69
74LS73	.45	74LS168	1.19	74LS373	1.95
74LS74	.45	74LS169	1.19	74LS374	1.95
74LS75	.59	74LS170	1.95	74LS375	.89
74LS76	.45	74LS173	.99	74LS386	.69
74LS78	.49	74LS174	.99	74LS393	2.49
74LS83	.89	74LS175	.99	74LS399	2.49
74LS85	1.25	74LS181	2.95	74LS670	2.49
74LS86	.49	74LS190	1.25	81LS95	1.95
74LS90	.69	74LS191	1.25	81LS97	1.95

74S

74S00	.45			74S243	3.25
74S02	.45			74S244	3.25
74S03	.45	74S124	3.95	74S251	1.45
74S04	.55	74S133	.55	74S253	1.45
74S05	.55	74S134	.69	74S257	1.35
74S08	.50	74S135	1.19	74S258	1.35
74S09	.50	74S136	1.75	74S260	.79
74S10	.45	74S138	1.35	74S280	2.95
74S11	.45	74S139	1.35	74S287	3.25
74S15	.45	74S140	.79	74S288	2.75
74S20	.45	74S151	1.35	74S373	3.49
74S22	.45	74S153	1.35	74S374	3.49
74S30	.45	74S157	1.35	74S387	2.95
74S32	.55	74S158	1.35	74S471	10.95
74S38	1.25	74S160	2.95	74S472	10.95
74S40	.50	74S174	1.59	74S473	10.95
74S51	.45	74S175	1.59	74S474	12.95
74S64	.50	74S188	2.95	74S475	12.95
74S65	.50	74S194	1.95	74S570	5.95
74S74	.75	74S195	1.95	74S571	5.95
74S86	.79	74S196	1.95	74S572	9.95
74S112	.79	74S240	2.95	74S573	9.95
74S113	.79	74S241	2.95	74S940	3.15
74S114	.79	74S242	3.25	74S941	3.15

CA—LINEAR

CA3010H	.99			CA3089N	3.75
CA3013H	2.15	CA3060N	3.25	CA3096N	3.95
CA3023H	3.25	CA3080H	1.25	CA3130H	1.39
CA3035H	2.49	CA3081N	2.00	CA3140H	1.25
CA3039H	1.35	CA3082N	2.00	CA3160H	1.25
CA3046N	1.30	CA3083N	1.60	CA3401N	.59
CA3059N	3.25	CA3086N	.85	CA3600N	3.50

CD—CMOS

CD4000	.39			CD 4098	2.49
CD4001	.39			CD4506	.75
CD4002	.39			CD4507	.99
CD4006	1.19	CD4041	1.49	CD4508	3.95
CD4007	.25	CD4042	.99	CD4510	1.39
CD4009	.49	CD4043	.89	CD4511	1.29
CD4010	.49	CD4044	.89	CD4512	1.49
CD4011	.39	CD4046	1.79	CD4514	3.95
CD4012	.25	CD4047	2.50	CD4515	2.95
CD4013	.49	CD4048	1.35	CD4516	1.49
CD4014	1.39	CD4049	.49	CD4518	1.79
CD4015	1.19	CD4050	.69	CD4519	.89
CD4016	.59	CD4051	1.19	CD4520	1.29
CD4017	1.19	CD4052	1.19	CD4526	1.79
CD4018	.99	CD4053	1.19	CD4528	1.79
CD4019	.49	CD4056	2.95	CD4529	1.95
CD4020	1.19	CD4059	9.95	CD4543	2.79
CD4021	1.39	CD4060	1.49	CD4562	11.95
CD4022	1.19	CD4066	.79	CD4566	2.79
CD4023	.29	CD4068	.39	CD4583	2.49
CD4024	.79	CD4069	.45	CD4584	.75
CD4025	.23	CD4070	.55	CD4723	1.95
CD4026	2.95	CD4071	.49	CD4724	1.95
CD4027	.69	CD4072	.49	MC14409	17.95
CD4028	.89	CD4073	.39	MC14410	18.95
CD4029	1.49	CD4075	.39	MC14411	15.95
CD4030	.49	CD4076	1.39	MC14412	15.95
CD4034	3.49	CD4078	.55	MC14419	7.95
CD4035	.99	CD4081	.39	MC14433	15.95
CD4040	1.49	CD4082	.39	MC14538	2.49
		CD4093	.99	MC14541	1.95

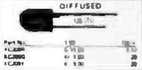
A-AMBER — **LEDS** — G-GREEN
R-RED Y-YELLOW C-CLEAR

OPTO ELECTRONICS — DISPLAY LEDS

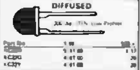
DIFFUSED BI COLOR/TRI STATE

POINT SOURCE (RED)

DIFFUSED

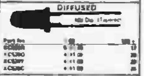


DIFFUSED

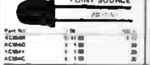


WIDE ANGLE DIFFUSED

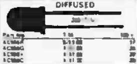
DIFFUSED



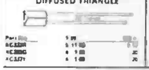
POINT SOURCE



DIFFUSED



DIFFUSED TRIANGLE



DIFFUSED RECTANGULAR

LED Mounting Hardware

Mounts in panels up to .125" thick. Drill .257" diameter hole (F Drill). Can be used with XC22, XC111, XC526, XC554 and XC556 Series (from .160" to .200 Dia.) Black plastic clip and ring

Part No.	1-99	100+
LMH-200	8/$1.00	.08 ea.

Part No.	Size	Color	Description	Price
MAN 1	.270	Red	C.A. (LHDP)	2.95
MAN 2	.320	Red	5x7 Alphanumeric (TIL305)	4.95
MAN 52	.300	Green	C.A. (LHDP)	.99
MAN 54	.300	Green	C.C. (RHDP)	.99
MAN 72	.300	Red	C.A. (LHDP)	.75
MAN 74	.300	Red	C.C. (RHDP)	1.25
NSN 74L	.300	Red	C.C. (LHDP)	.99
MAN 82	.300	Yellow	C.A. (LHDP)	.49
MAN 84	.300	Yellow	C.C. (RHDP)	.99
MAN 3620	.300	Orange	C.A. (LHDP)	.49
MAN 3630	.300	Orange	C.A. (±1) Over Flo	.99
MAN 4610	.400	Orange	C.A. (RHDP)	.99
MAN 6610	.560	Orange	C.A. (RHDP) 2 Digit	.99
MAN 6630	.560	Orange	C.A. (±1) 1½ Digit	.99
MAN 6640	.560	Orange	C.C. (RHDP) 2 Digit	.99
MAN 6650	.560	Orange	C.C. (±1) 1½ Digit	.99
MAN 6660	.560	Orange	C.A. (RHDP)	.99
MAN 6710	.560	Red	C.A. (RHDP) 2 Digit	.99
MAN 6740	.560	Red	C.C. (RHDP) 2 Digit	.99
MAN 6750	.560	Red	C.C. (±1) 1½ Digit	.99
DL 34M	.110	Red	C.C. (4 Digit Bubble) RHDP	.49
DLO 304	.300	Orange	C.C. (RHDP)	1.25
DLO 307	.300	Orange	C.A. (LHDP)	1.25
DLG 500	.500	Green	C.C. (RHDP)	1.25
DLG 507	.500	Green	C.A. (RHDP)	1.25
DL 704	.300	Red	C.C. (RHDP)	1.25
DL 707	.300	Red	C.A. (LHDP)	1.25
DL 747	.630	Red	C.A. (LHDP)	1.49
DL 750	.630	Red	C.C. (LHDP)	1.49
FND 350	.362	Red	C.A. (RHDP)	.75
FND 357	.362	Red	C.C. (RHDP) FND 359	.75
FND 500	.500	Red	C.C. (RHDP) FND 503	.99
FND 507	.500	Red	C.A. (RHDP) FND 510	.99
TIL 308	.270	Red	Numerical Display w/Logic	10.95
TIL 311	.270	Red	4x7 Hexadecimal w/Logic	10.95
5082-7300	.600	Red	4x7 Numeric (RHDP)	22.00
5082-7302	.600	Red	4x7 Numeric (LHDP)	22.00
5082-7304	.600	Red	Over Flo (±1) for 5082-7300 or	19.95
5082-7340	.800	Red	4x7 Hexadecimal (0-9/A-F)	22.50
5082-7432	.110	Red	C.C. (2 Digit/3-Bubble)	.29
HDSP-3401	.800 20mm	Red	C.A. (RHDP)	1.50
HDSP-3403	.800 20mm	Red	C.C. (RHDP)	1.80
HDSP-3406	.800 20mm	Red	C.C. (RHDP) ±1 Over Flo	1.50

Many Other Displays Available — Send for New Catalog

OPTO ISOLATORS

H11C3	SCR Output Opto Isolators	$1.19
LIT-1	Single Chan. 20% CTR, 2500V (MCT-2/4N25)	.69
4N28	Single Chan. 10% CTR, 500V (Photo Transistor)	.69
4N33	Single Chan. 500% 1500V (Photo-Darlington)	1.25
MOC3010	Optically Isolated Triac Driver	1.25

LITRONIX-NATIONAL Stick Display Sale

LIMITED QUANTITY!

LED NUMERIC ARRAYS*

PART NO	DIGIT SIZE (RED)	FORMAT	DRIVE Comm. Cathode/Comm. Anode	OVERALL SIZE	PRICE	SALE PRICE!
NSA1[illegible]	.100 (9 Bubble Stick)	888888	CC 6 Digit Multiplexed	2"L x .72"H x .27"D	[illegible]	2/[illegible]
NSA1[illegible]	.100 (9 Bubble Stick)	888888888	CC 9 Digit Multiplexed	2"L x .72"H x .27"D	[illegible]	2/[illegible]
NSA2[illegible]	.100 (9 Bubble Stick)	888888888	CC 9 Digit Multiplexed	1.[illegible]"L x .72"H x .27"D	[illegible]	2/[illegible]
NSA1[illegible]	.100 (9 Bubble Stick)	8 88 88	CC 5 Digit Multiplexed	2"L x .72"H x .27"D	[illegible]	2/[illegible]

*Standard Sin[illegible]

MULTI-DIGIT LED NUMERIC DISPLAYS

PART NO	DIGIT SIZE (RED)	FORMAT	DRIVE Comm. Cathode/Comm. Anode	OVERALL SIZE	PRICE	SALE PRICE!
NSN373	.3 No Decimal	88	CC 2 Digit Direct	.80"L x .80"H x .225"D	[illegible]	2/.79
NSN374	.3 No Decimal	88	CA 2 Digit Direct	.80"L x .80"H x .225"D	[illegible]	2/.[illegible]
[illegible]	.5 No Decimal	88	CA 2 Digit Direct	1.4[illegible]"L x 1.14"H x .32"D	[illegible]	2/1.40
[illegible]	.7	88	CC 2 Digit Multiplexed	1.2"L x 1.25"H x .3"D	1.[illegible]	2/1.[illegible]
[illegible]	.3	88/88 88.8888	CC 8 Digit (10 Spaces)	4"L x .60"H x .250"D	.75	2/.[illegible]
[illegible]	.3	8888	CA 4 Digit Multiplexed	1.50"L x .[illegible]"H x .25"D	.75	2/.[illegible]
[illegible]	.3	±1888	CA 3½ Digit Multiplexed	1.50"L x .[illegible]"H x .225"D	[illegible]	2/1.40
[illegible]	.3	88 88	CC 4 Digit Colon/PM Indicator	1-9/16"L x 13/16"H x 3/16"D	[illegible]	2/1.19
[illegible]	.3	88 88 88	CC 6 Digit AM/PM, Failure Ind	2"L x 1.10"H x .32"D	[illegible]	2/3.[illegible]
[illegible]	.3	88888888	CC 8 Digit Multiplexed	2"L x 1-3/32"H x 3/16"D	[illegible]	2/3.[illegible]
NS[illegible]	.3	8888	CC 4 Digit Multiplexed	1.5[illegible]"L x .80"H x .225"D	[illegible]	2/4.[illegible]
NS[illegible]	.3	8888	CA 4 Digit Multiplexed	1.[illegible]"L x .[illegible]"H x .225"D	[illegible]	2/4.[illegible]
NS[illegible]	.5	±1888	CA 3½ Digit Multiplexed	1.[illegible]"L x 1.[illegible]"H x .[illegible]"D	[illegible]	2/5.[illegible]
NS[illegible]	.5	88 88	CC 4 Digit - AM/PM, Colon Ind	3.00"L x 1.10"H x .[illegible]"D	[illegible]	2/3.95
[illegible]	.5	8888	CC 4 Digit Multiplexed	1.[illegible]"L x 1.00"H x .[illegible]"D	[illegible]	2/5.[illegible]
[illegible]	.5	8888	CA 4 Digit Multiplexed	1.[illegible]"L x 1.00"H x .[illegible]"D	[illegible]	2/5.[illegible]
[illegible]	.5	±888	CC 3½ Digit Multiplexed	3.00"L x 1.10"H x .[illegible]"D	2.[illegible]	2/3.49
[illegible]	.5	88888	CA 5 Digit Multiplexed	3.00"L x 1.10"H x .[illegible]"D	[illegible]	2/3.49
[illegible]	.7	888888	CC 4 Digit Multiplexed/Direct	3.[illegible]"L x 1.35"H x .[illegible]"D	[illegible]	2/4.95
DL2300	.3	88	CC 2 Digit Multiplexed	13/16" x 7/8" x 1/4"	[illegible]	2/.99
DLG2[illegible]	.5 (Green)	88	CA 2 Digit Multiplexed	1-5/16" x 1-1/2" x 5/16"	[illegible]	2/1.19
DL3[illegible]	1.0	888	CA 3 Digit Multiplexed	2-3/4" x 1-13/16" x 5/16"	2.[illegible]	2/3.49
DL4[illegible]	.5	8888	CC 4 Digit MPX, Colon	3-3/16" x 1-1/4" x 5/16"	[illegible]	2/2.[illegible]
DL4[illegible]	.5	8888	CC 4 Digit MPX, Colon	3-3/16" x 1 x 5/16"	1.[illegible]	2/2.[illegible]
DLG4[illegible]	.5 (Green)	8888	CC 4 Digit Non Multiplexed	3-3/16" x 1 x 5/16"	[illegible]	2/7.[illegible]
DL4[illegible]	.5	8888	CC 4 Digit Multiplexed	2" x 1-5/16" x 5/16"	1.[illegible]	2/1.[illegible]
DL4520A	.5	8888	CC 4 Digit Non Multiplexed	3-3/16" x 1" x 5/16"	2.[illegible]	2/2.[illegible]

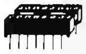
COMPUTER GRADE CAPACITORS

1¢ SALE!

2 FOR THE PRICE OF ONE PLUS 1¢ MORE

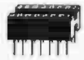
MFD	WVDC	PRICE	MFD	WVDC	PRICE	MFD	WVDC	PRICE
250	150	1.95	7,000	60	4.95	27,000	10	2.95
500	200	2.49	10,000	15	2.95	32,500	25	4.55
1,250	3	.99	10,000	18	3.95	40,000	25	5.95
1,500	25	1.95	11,000	19	4.95	42,000	10	4.55
1,500	50	2.95	13,000	16	2.95	43,000	10	5.95
2,000	10	2.95	14,000	13	2.95	45,000	5	5.55
2,100	200	2.95	14,000	35	3.95	52,000	20	5.95
2,250	100	3.95	18,000	10	3.95	55,000	15	5.95
2,300	33	2.95	20,000	20	2.95	58,000	20	5.95
2,500	15	2.95	21,000	15	3.95	65,000	10	7.95
3,000	25	1.95	22,000	15	4.95	73,800	5	7.95
3,600	40	3.95	23,000	7	1.95	80,000	15	9.95
4,500	50	3.95	23,000	10	2.95	90,000	10	8.95
5,500	25	4.49	23,000	20	3.95	120,000	15	10.95
6,100	40	2.49	24,000	20	2.95	160,000	10	8.95

OVER 200 OTHER VALUES AVAILABLE — CALL OR WRITE FOR YOUR REQUIREMENT



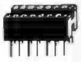
LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61



SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30



SOLDERTAIL (GOLD) STANDARD

	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

JUMPER AND CABLE ASSEMBLIES

STANDARD DIP JUMPERS

All jumpers use low profile dip plugs with heavy duty pins for repeated disconnect applications.

JAMECO Part No	AP Cross Reference	No Pins	Description	Wire Length	Price
DJ14-1	924102 12	14	single end	12"	$1.29
DJ14-2	924102 24	14	single end	24"	2.05
DJ14-3	924102 36	14	single end	36"	2.35
DJ14-1-14	924106 12	14	double end	12"	3.20
DJ14-2-14	924106 24	14	double end	24"	3.49
DJ14-3-14	924106 36	14	double end	36"	3.79
DJ16-1	924112 12	16	single end	12"	1.85
DJ16-2	924112 24	16	single end	24"	2.19
DJ16-3	924112 36	16	single end	36"	2.59
DJ16-1-16	924116 12	16	double end	12"	3.35
DJ16-2-16	924116 24	16	double end	24"	3.69
DJ16-3-16	924116 36	16	double end	36"	4.05
DJ24-1	924122 12	24	single end	12"	2.69
DJ24-2	924122 24	24	single end	24"	3.39
DJ24-3	924122 36	24	single end	36"	3.95
DJ24-1-24	924126 12	24	double end	12"	4.79
DJ24-2-24	924126 24	24	double end	24"	5.29
DJ24-3-24	924126 36	24	double end	36"	5.89

JAMECO Part No	AP Cross Reference	No Pins	Description	Wire Length	Price
DJ40-1	924132 12	40	single end	12"	5.89
DJ40-2	924132 24	40	single end	24"	6.79
DJ40-3	924132 36	40	single end	36"	7.69
DJ40-1-40	924136 12	40	double end	12"	10.95
DJ40-2-40	924136 24	40	double end	24"	11.89
DJ40-3-40	924136 36	40	double end	36"	12.79

STANDARD DB25 SERIES CABLES

Now you can order DB25 P or S connectors with the cable necessary to fit your application. Choose from our standard flat cable in 4 foot lengths.

STANDARD CABLES

Part No.	Cable Length	Connectors	Price
DB25P-4	4 feet	1-DB25P	$ 9.95 ea.
DB25S-4	4 feet	1-DB25S	10.95 ea.
DB25P-4-P	4 feet	2-DB25P	16.95 ea.
DB25P-4-S	4 feet	1-DB25P/1-DB25S	17.95 ea.
DB25S-4-S	4 feet	2-DB25S	18.95 ea.

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INTERSIL

Part No.	Function	Price
7045IPI	CMOS Precision Timer	14.95
7045EV/Kit*	Stopwatch Chip, XTL	24.95
7106CPL	3½ Digit A/D (LCD Drive)	16.95
7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.95
7107EV/Kit*	IC, Circuit Board, Display	29.95
7116CPL	3½ Digit A/D LCD Dis. HLD.	18.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
72011DR	Low Battery Volt Indicator	2.25
72051PG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.95
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	12.95
7207AIPD	Oscillator Controller	6.50
7207AEV/Kit*	Freq. Counter Chip, XTL	13.95
72081PI	Seven Decade Counter	17.95
72091PA	Clock Generator	3.95
72151PG	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL	19.95
7216AIJI	8-Digit Univ. Counter C.A.	32.00
7216CIJI	8-Digit Freq. Counter C.A.	26.95
7216DIPI	8-Digit Freq. Counter C.C.	21.95
72171JI	4-Digit LED Up/Down Counter CA	12.95
7217AIPI	4-Digit LED Up/Down Counter CC	14.95
72241PL	LCD 4½ Digit Up Counter DRI	11.25
7226AIJL	8-Digit Univ. Counter	31.95
7226AEV/Kit*	5 Function Counter Chip, XTL	74.95
72401JE	CMOS Bin Prog. Timer/Counter	4.95
72421JA	CMOS Divide-by-256 RC Timer	2.05
72501JE	CMOS BCD Prog. Timer/Counter	6.00
72601JE	CMOS BCD Prog. Timer/Counter	5.25
75551PA	CMOS 555 Timer (8 pin)	1.45
75561PD	CMOS 556 Timer (14 pin)	2.20
7611BCPA	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr. 5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp. 5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7660CPA	Voltage Converter	2.95
8038CCPD	Waveform Generator	4.95
8048CCPE	Monolithic Logarithmic Amp	21.60
8069CCQ	50ppm Band—GAP Volt Ref. Diode	2.50
8211CPA	Volt Ref/Indicator	2.95
8212CPA	Volt Ref/Indicator	2.95

74C

74C00	.39			74C221	1.95
74C02	.39	74C95	1.59	74C240	2.25
74C04	.39	74C107	1.89	74C244	2.25
74C08	.39	74C151	2.95	74C373	2.49
74C10	.39	74C154	3.95	74C374	2.59
74C14	.75	74C157	2.25	74C901	.69
74C20	.39	74C160	1.69	74C903	.69
74C30	.39	74C161	1.60	74C911	10.95
74C42	1.39	74C162	1.49	74C912	10.95
74C48	1.95	74C163	1.69	74C915	1.69
74C73	.79	74C164	1.59	74C917	10.95
74C74	.79	74C173	1.39	74C922	5.49
74C85	1.95	74C174	1.39	74C923	5.75
74C86	.99	74C175	1.19	74C925	7.50
74C89	6.95	74C192	1.69	74C926	7.50
74C90	1.29	74C193	1.69	80C95	.79
74C93	1.29	74C195	1.59	80C97	.79

LINEAR

LH0002CN	6.85			LM702H	.79
LM10CLH	4.50			LM703CN	.89
LM11CLH	4.75	LM340T-5	1.25	LM709N	.29
LH0070-OH	4.95	LM340T-12	1.25	LM710N	.79
TL071CP	.79	LM340T-15	1.25	LM711N	.79
TL072CP	1.39	LM341P-5	.75	LM723N	.69
TL074CN	2.49	LM341P-12	.75	LM733N	1.00
LH0082CD	35.80	LM341P-15	.75	LM739N	1.19
TL082CP	1.19	LM342P-5	.69	LM741CN	.35
TL084CN	2.19	LM342P-12	.69	MC1741SCG	3.00
LH0094CD	36.80	LM342P-15	.69	LM747N	.79
LM300H	.99	LM348N	1.25	LM748N	.59
LM301CN	.35	LM350K	5.75	LM1014N	2.75
LM302H	1.95	LF351N	.60	LM1310N	1.95
LM304H	1.95	LF353N	1.00	LM1458CN	.59
LM305H	.99	LF355N	1.10	LM1488N	1.25
LM307CN	.45	LF356N	1.10	LM1489N	1.25
LM308CN	1.00	LM358N	1.00	LM1496N	1.95
LM309H	1.95	LM359N	1.79	LM1556V	1.75
LM309K	1.25	LM370N	4.49	LM1800N	2.95
LM310CN	1.75	LM373N	3.25	LM1871N	5.49
LM311/CN	.90	LM377N	2.95	LM1872N	5.49
LM312H	2.49	LM380N	1.25	LM1877N-9	3.25
LM317MP	1.15	LM381N	1.95	LM1889N	3.20
LM317T	1.75	LM382N	1.79	LM1896N	1.75
LM317K	3.95	LM384N	1.95	LM2002T	1.49
LM318CN	1.95	LM386N-3	1.29	LM2877P	2.05
LM319N	1.95	LM387N	1.45	LM2878P	2.25
LM320K-5	1.35	LM389N	1.35	LM2896P-1	2.25
LM320K-12	1.35	LM392N	.69	LM3189N	2.95
LM320K-15	1.35	LF398N	4.00	LM3900N	.69
LM320T-5	1.25	LM399H	5.00	LM3905CN	1.25
LM320T-12	1.25	TL494CN	4.49	LM3909N	1.15
LM320T-15	1.25	TL496CP	1.75	LM3914N	3.95
LM323K	5.95	NE510A	6.00	LM3915N	3.95
LM324N	.99	NE529A	4.95	LM3916N	3.95
LM329DZ	.65	NE531H	3.95	RC4136N	1.25
LM331N	3.95	NE536H	6.00	RC4151NB	3.95
LM334Z	1.30	NE540H	6.00	RC4194TK	6.95
LM335Z	1.40	NE544N	4.95	RC4195TK	5.49
LM336Z	1.75	NE550A	1.30	LM4500A	3.25
LM337T	1.95	NE555V	.39	ICL8038B	4.95
LM337MP	1.15	LM556N	.99	LM13080N	1.29
LM338K	6.95	NE564N	3.95	LM13600N	1.49
LM339N	.99	LM565N	1.25	75138N	1.95
LM340K-5	1.35	LM566CN	1.95	75450N	.89
LM340K-12	1.35	LM567V	1.25	75451CN	.39
LM340K-15	1.35	NE570N	4.95	75492	.89

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
10 pf	.08	.06	.05	.001µF	.08	.06	.05
22 pf	.08	.06	.05	.0047µF	.08	.06	.05
47 pf	.08	.06	.05	.01µF	.08	.06	.05
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
470 pf	.08	.06	.05	.1µF	.15	.12	.10

100 VOLT MYLAR FILM CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022mf	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (Solid) CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
.1/35V	.39	.34	.29	1.5/35V	.41	.37	.29
.15/35V	.39	.34	.29	2.2/35V	.51	.45	.34
.22/35V	.39	.34	.29	3.3/25V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.69	.55
.68/35V	.39	.34	.29	15/25V	1.39	1.25	.95
1.0/35V	.39	.34	.29	22/6V	.79	.69	.55

MINI. ALUMINUM ELECTROLYTIC CAPACITORS

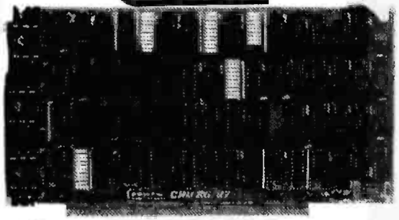
Axial	1-99	100-499	500+	Radial	1-99	100-499	500+
.47/50V	.16	.14	.10	.47/25V	.15	.13	.12
1.0/50V	.19	.16	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.49	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.25	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

Circle 248 on inquiry card.

PRIORITY ONE ELECTRONICS

1 ONE

CompuPro™



NEW!

CPU BOARDS

CO-PROCESSOR 8086/8087 (816)

16 bit 8 or 10 MHz 8086 CPU with sockets for 8087 and 80130

Part No.	Description	List Price	Our Price
BFGBT186A	A&T 8MHz 8086 only	$695.00	$ 625.00
BFGBAT186C	CSC 10MHz 8086 only	$850.00	$765.00
BFGBT186A87	A&T with 8087 option	$1295.00	$1225.00
BFGBT186C87	CSC with 8087 option*	$1550.00	$1456.00

**8087 requires slower clock speeds*

DUAL PROCESSOR 8085-8088

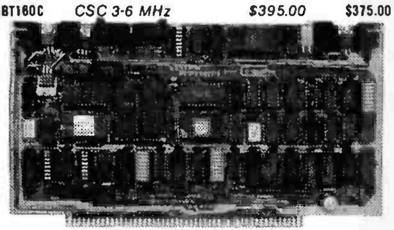
6 or 8 MHz Provides true 16 Bit Power with a standard 8 bit S-100 bus

BFGBT1612A	A&T 6Mhz	$425.00	$399.00
BFGBT1612C	CSC 6/8 MHz	$525.00	$498.00

CPU-Z Z80 CPU

2/4 MHz Z80 CPU 24 Bit Addressing

BFGBT160A	A&T	$295.00	$260.00
BFGBT160C	CSC 3-6 MHz	$395.00	$375.00



I/O BOARDS

SYSTEM SUPPORT 1 MULTIFUNCTION BOARD

Serial port (software prog. baud), 4K EPROM or RAM provision, 15 levels of interrupt, real time clock, optional math processor

Part No.	Description	List Price	Our Price
BFGBT162A	Assembled & Tested	$399.00	$360.00
BFGBT162C	CSC	$495.00	$460.00
BFGBT8231	Math Chip		$195.00
BFGBT8232	Math Chip		$195.00
BFGBT162AM1	A&T with 8231 Math Chip		$555.00
BFGBT162CM1	CSC w/8231 Math Chip		$655.00
BFGBT162AM2	A&T w/8232 Math Chip		$555.00
BFGBT162CM2	CSC w/8232 Math Chip		$655.00

MPX CHANNEL BOARD

I/O Multiplexer, using 8085A-2 CPU on board with 4K RAM

BFGBT166A4	Assembled & Tested	$495.00	$445.00
BFGBT166C4	CSC	$595.00	$535.00
	With 16K RAM		
BFGBT166A16	Assembled & Tested	$649.00	$585.00
BFGBT166C16	CSC	$749.00	$675.00

INTERFACER 1

Two Serial I/O

BFGBT133A	Assembled & Tested	$249.00	$219.00
BFGBT133C	CSC	$324.00	$298.00

INTERFACER 2

Three parallel, one serial I/O board

BFGBT150A	Assembled & Tested	$249.00	$219.00
BFGBT150C	CSC	$324.00	$289.00

INTERFACER 3

Eight channel multi-use serial I/O board

BFGBT1748A	Assembled & Tested	$699.00	$629.00
BFGBT1748C	CSC 200 hr. 8 Port	$849.00	$750.00
BFGBT1745A	Assembled & Tested	$599.00	$559.00
BFGBT1745C	CSC 200hr. 5 port	$699.00	$629.00

NEW!

INTERFACER 4

Three Serial, 1 Parallel, 1 Centronics Parallel

BFGBT187A	Assembled & Tested	$350.00	$315.00
BFGBT187C	CSC	$450.00	$415.00

SPECTRUM COLOR GRAPHICS

Color Graphics board with Parallel I/O

BFGBT144A	Assembled & Tested	$399.00	$349.00
BFGBT144C	CSC	$449.00	$339.00
BFGBT20	Sublogic Universal Graphics Interpreter Software		$35.00

S-100 MOTHERBOARDS

Active termination, 6-12-20 Slot

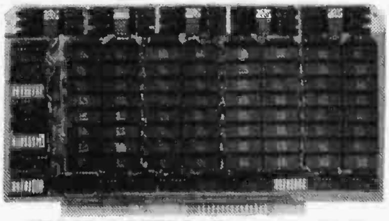
BFGBT153A	A&T 6 slot, 2 lbs.	$140.00	$126.00
BFGBT153C	CSC 6 slot, 2 lbs.	$190.00	$175.00
BFGBT154A	A&T 12 slot, 3 lbs.	$175.00	$155.00
BFGBT154C	CSC 12 slot, 3 lbs.	$240.00	$220.00
BFGBT155A	A&T 20 slot, 4 lbs.	$265.00	$235.00
BFGBT155C	CSC 20 slot, 4 lbs.	$340.00	$310.00

ACTIVE TERMINATOR

Allows older S-100 motherboards to run faster and quieter

BFGBT106A	Assembled & Tested		$59.50

CompuPro™



STATIC MEMORY BOARDS

RAM 20 - 32K STATIC RAM

RAM 20 10 MHz, 4K byte block disable, bank select or 24 bit addressing available 8, 16, 24 or 32K

Part No.	Description	List Price	Our Price
BFGBT164AA8	8K A&T	$210.00	$190.00
BFGBT164AC8	8K CSC	$280.00	$260.00
BFGBT164AA16	16K A&T	$285.00	$260.00
BFGBT164AC16	16K CSC	$355.00	$325.00
BFGBT164AA24	24K A&T	$355.00	$325.00
BFGBT164AC24	24K CSC	$425.00	$365.00
BFGBT164AA32	32K A&T	$425.00	$365.00
BFGBT164AC32	32K CSC	$495.00	$450.00

CMOS STATIC RAM

For a complete analysis of the advantages of CMOS memory, see the "Product Description" on page 416 of the January Issue of BYTE

RAM 17 - 64K CMOS STATIC RAM

RAM 17, 10 MHz, 2 Watt, DMA Compatible 24 Bit Addressing

BFGBT175A64	64K A&T	$599.00	$550.00
BFGBT175C64	64K CSC	$750.00	$699.00

RAM 16 - 32K x 16 BIT CMOS STATIC RAM

8 and/or 16 Bit

(816) RAM 16 10 MHz, 32K x 16 or 64K x 8

IEEE/696 16 Bit 2 Watt, 24 Bit Addressing

BFGBT180A	64K A&T	$650.00	$599.00
BFGBT180C	64K CSC	$750.00	$699.00

NEW! RAM 21 - 128K STATIC RAM

(816) RAM 21 12MHz, 128K x 8 or 64K x 16

IEEE/696 8 or 16 Bit 1.2 Amps, 24 Bit Addressing

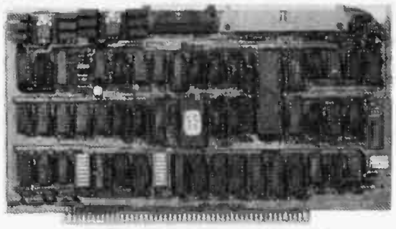
BFGBT190A	128K A&T	$1695.00	$1610.00
BFGBT190C	128K CSC	$1895.00	$1795.00

M-DRIVE SOLID STATE DISK DRIVE, 3500% FASTER! (816)

Not Really, But the Next Best Thing for CompuPro 8085/88 Users. Call for Detail on M-Drive.

M-Drive requires a 6MHz CPU 8085/88 dual processor, Disk 1 DMA disk controller and System Suport 1 Multifunction Board

BFGBTM0128K	128K of A&T memory & M-DriveSoftware	$1198.00
BFGBTMD128KC	128K of CSC memory & M-Drive Software	$1398.00
BFGBTM0256KA	256K of A&T memory & M-DriveSoftware	$2395.00
BFGBTM0256KC	256K of CSC memory & M-Drive Software	$2795.00



DISK CONTROLLERS

DISK 1 FLOPPY CONTROLLER

Fast DMA, Soft Sector, Controls 8" or 5¼" Single or Double Density. OUR BEST!

BFGBT171A	A&T	$495.00	$450.00
BFGBT171C	CSC	$595.00	$555.00
BFGBTCPM80*	CP/M 2.2 for Z80/8085 with manuals & BIOS 8" S/D disk		$175.00
BFGBTCPM86	CP/M for 8086 with manuals & BIOS 8" S/D disk		$300.00
BFGBTOAS8S	Oasis 8 bit single user 8" S/D disk		$500.00
BFGBTOAS8M	Oasis 8 bit multiuser, 8" S/D disk		$850.00

NEW!

DISK 2/SELECTOR CHANNEL HARD DISK CONTROLLER

Fast DMA 2 board set.Controls 4 Shugart 4000 series or Fujitsu 2300 type drives

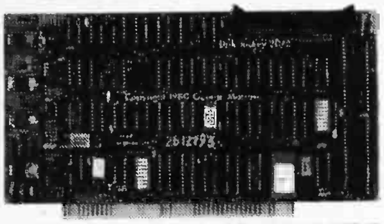
BFGBT177A	Assembled & Tested	$795.00	$750.00
BFGBT177C	CSC	$895.00	$850.00

S-100 MAINFRAME

110V 60Hz CVT Mainframe uses famous 20 slot COMPUPRO Motherboard. 55 lbs.

BFGBTENC20RM	20 Slot Rack Mount	$895.00	$825.00
BFGBTENC20DK	20 Slot Desk Top	$825.00	$760.00

MORROW DESIGNS



FLOPPY DISK CONTROLLERS & SUBSYSTEMS

DISK JOCKEY 2B FLOPPY CONTROLLER

Memory mapped controller handles 4 8" drives, single or double density

Part No.	Description	List Price	Our Price
BFMOSOJ2208	A&T w/CP/M™ 2.2	$399.00	$375.00

DISCUS 2D & DISCUS 2+2 SUBSYSTEMS

Each subsystem includes DJ/2B controller 8" double density drives with cabinet, power supply, CP/M™ 2.2 and Microsoft Basic

SINGLE SIDED - DISCUS 2D

BFMDSF1218	1 Drive	30 lbs.	$1095.00	$ 950.00
BFMOSF1228	2 Drive	48 lbs.	$1875.00	$1675.00

DOUBLE SIDED - DISCUS 2+2

BFMDSBF612	1 Drive	30 lbs.	$1395.00	$1250.00
BFMDSBF622	2 Drive	48 lbs.	$2495.00	$2200.00

DISK JOCKEY/DMA FLOPPY CONTROLLER

DMA Controller supports 4 soft-sectored 8" drives and 4 10 sector 5¼" drives simultaneously. On board Z80A

BFMOSDJDMA	A&T w/CP/M™ 2.2	$495.00	$450.00

DISK JOCKEY DMA SUBSYSTEMS

Each subsystem includes DJ/DMA controller, 8" double-density drives or 5¼" 48 TPI drives, cabinet, power supply, CP/M™ 2.2 and Microsoft BASIC

SINGLE SIDED DISCUS 2D/DMA

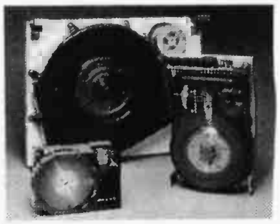
BFMOSOF611	1 Drive	30 lbs.	$1195.00	$1050.00
BFMOSOF621	2 Drive	48 lbs.	$1975.00	$1775.00

DOUBLE SIDED DISCUS 2+2/DMA

BFMOSDF612	1 Drive	30 lbs.	$1495.00	$1325.00
BFMOSOF622	2 Drive	48 lbs.	$2575.00	$2295.00

DOUBLE SIDED - DISCUS MINI-FLOPPY/DMA

BFMOSOF5124	1 Drive	17 lbs.	$ 995.00	$895.00
BFMOSOF5224	2 Drive	32 lbs.	$1695.00	$1525.00



NEW!

S-100 5-26 MB HARD DISK SUBSYSTEMS

5 - 10 Mb DMA SUBSYSTEMS

Each subsystem Includes DMA Hard Disk Controller, Seagate ST506 5 Mb or ST412 10 Mb 5¼" Hard Disk, Cabinet, power supply, CP/M™ 2.2 and Microsoft BASIC.

BFMOSOMAM*	Software supplied on 8" IBM 3740 disk with blank I/O and INSTALL program
BFMOSDMAM*2B	Software configured for Morrow DJ/2B controller and Mult I/O as console
BFMOSOMAM*OMA	Software configured for Morrow DJ/DMA controller and Mult I/O as console
BFMOSOMAM*NS	Software suplied on 5¼" 10 sector North Star disk with blank I/O and INSTALL Program

*Replace * in above part numbers with 5 for 5Mb Subsystems or 10 for 10Mb Subsystems.*

DISCUSM5 - 5Mb Subsystems	$2195.00	$1975.00
DISCUSM10 - 10Mb Subsystems	$3195.00	$2875.00

(order by part numbers listed above)

DISCUS HDC 20-26 Mb SUBSYSTEMS

Each subsystem includes HDCA3 I/O mapped controller, Shugart SA4008 14" 26Mb or Fujitsu 2308 8" 20Mb Hard Disk, cabinet, power supply, CP/M™ 2.2 & Microsoft BASIC.

BFMDSHDC20	Discus M20 A&T	$4795.00	$3995.00
BFMDSHDC26	Discus M26 A&T	$4495.00	$3895.00

I/O BOARDS

MULTI I/O

Three Serial, Two Parallel

BFMOSM83200	Assembled & Tested	$359.00	$329.00

SWITCHBOARD

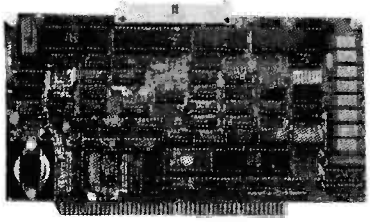
Two serial I/O, four parallel I/O, one status port, one strobe port

BFMDSSB2411	$299.00	$269.00

Circle 370 on inquiry card.

PRIORITY ONE ELECTRONICS

ADVANCED MICRO DIGITAL CORPORATION

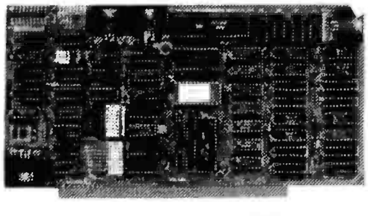


SUPERQUAD - ADVANCED MICRO DIGITAL AT LAST, A FULL S-100 SYSTEM ON A SINGLE BOARD!

• IEEE S-100 Bus Compatible • Z80A CPU @ 4MHz • Floppy Disk Controller, Single & Double Density (Supports up to 4 disk drives 5¼" or 8") • 64Kb Memory, 16K Bank Selectable • S-100 Extended Address A16-23 • 2 Serial and 2 Parallel I/O Ports • 2K or 4K of Shadow EPROM • Real Time Interrupt Clock • One Year Warranty • Runs with CP/M, MP/M, CP/NET • All of These Features on a Single Standard Size S-100 Board

Part No.	Description	List Price	Our Price
BFMADSDC1	*A&T w/Asych RS232 ports*	$875.00	$795.00
BFMAOPS1	*1 Asych adapter board required for each serial port used*		$ 30.00

SSM



VIDEO AND I/O

VB 3 - HIGH RESOLUTION VIDEO

80 x 25 or 50 character video display Memory Mapped, Parallel Keyboard port

BFSSMVB3A24	*80 x 24 A&T*	$499.00	$440.00
BFSSMVB3UP	*80 x 50 Line Upgrade*		$ 39.00

VB 2 - I/O MAPPED 64 x 16 DISPLAY

I/O Mapped Video Board, with Parallel Keyboard port 64 x 16

BFSSMVB24A	*Assembled & Tested*	$269.00	$229.00

VB1B MEMORY MAPPED 64 x 16 DISPLAY

Memory Mapped Video Board 64 x 16 character display or 64 x 16 graphics display

BFSSMVB1A	*Assembled & Tested*	$242.00	$220.00

I/O 4

Two serial I/O, two parallel I/O

BFSSMI04A	*Assembled & Tested*	$290.00	$260.00

NEW!

I/O 5

2 Serial, 3 parallel Including 1 Centronics

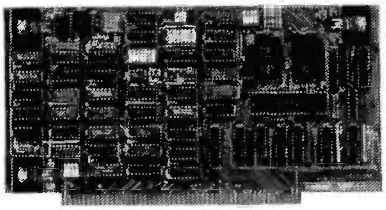
BFSSMI051	*Assembled & Tested*	$329.00	$309.00

NEW!

I/O 8

8 Port Serial I/O with Timer

BFSSMI08A	*Assembled & Tested*	$550.00	$495.00



CPU, RAM & PROM

CB2 Z80 CPU

2/4 MHz will accept 2716, or 2732, or RAM

BFSSMCB2A	*Assembled & Tested*	$299.00	$275.00
BFSSMZ80M	*SSM Z80 Monitor*		$ 89.00

MB10A 16/8K 8/16 BIT STATIC RAM

16K byte /8K word, 24 bit extended, addressing, "M write," Phantom disable, addressable in 4K blocks

BFSSMMB10A	*Assembled & Tested*	$299.00	$275.00

MB8A 1K/16K EPROM BOARD

1K/16K 2708 EPROM board, disable in 1K increments

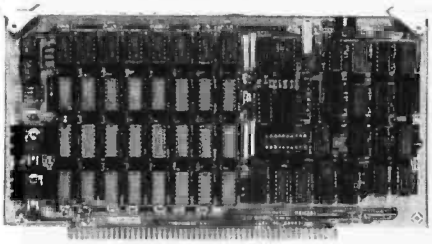
BFSSMMB8AA	*Assembled & Tested*	$179.00	$158.00

PBI PROM PROGRAMMER

Programs 2708 or 2716's, operates as a 4K/8K EPROM BOARD AS WELL

BFSSMPB1A	*Assembled & Tested*	$265.00	$220.00

California Computer Systems



CPU BOARDS

2810 Z80 SBC CPU

2/4 MHz Z80A CPU with RS232C Serial I/O Port complete with Monitor PROM for 2422 Disk Controller

Part No.	Description	List Price	Our Price
BFCCS2810A	*Assembled & Tested*		$300.00

2820 Z80 DMA CPU

4MHz Z80 with 2 RS232C Serial Ports, Centronics Parallel Port, separate data and status ports and DMA Daisy Chain Capability

BFCCS2820	*Assembled & Tested*		$595.00

I/O BOARDS

2830 - 6 PORT SERIAL

Six Asynchronous RS232C Ports using three Z-80 DARTS. Programmable baud rates.

BFCCS2830	*Assembled & Tested*		$550.00

2710 4 PORT SERIAL

4 Full handshaking RS232 ports and optional 2K ROM

BFCCS271001	*Assembled & Tested*		$325.00

2719 2 SERIAL & 2 PARALLEL

2 RS232C ports, 2 8 bit parallel ports & optional 2K ROM

BFCCS271901	*Assembled & Tested*		$360.00

2720 4 PORT PARALLEL

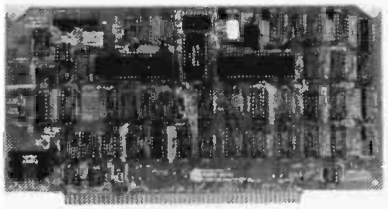
4 8 bit parallel ports and optional 2K ROM

BFCCS272001	*Assembled & Tested*		$275.00

2422 FLOPPY DISK CONTROLLER

I/O Mapped, controls 8", single or 5¼" double density A&T with CPM™ 2.2 8" S.D.

BFCCS2422A	*Assembled & Tested*		$425.00



MEMORY BOARDS

2065 64K DYNAMIC MEMORY BOARD

64K 4MHz, Z80 or 8080 compatible, bank select for memory expansion to 512K. DMA compatible.

BFCCS2065	*Assembled & Tested*	$375.00	$350.00

2066 BANK SWITCH DYNAMIC MEMORY

64K Memory with bank and block select switching functions for Cromemco Cromix™ & Alpha Microsystems

BFCCS2066	*Assembled & Tested*	$450.00	$425.00

2116 16K STATIC RAM

16K 4MHz using 2114 RAMs. Maybe divided into 4K blocks Cromemco & Alpha Microsystems compatible

BFCCS21163	*Assembled & Tested*		$295.00

2032 32K STATIC RAM

32K 4MHz using 2114s. Divided into 4 8K blocks. Bank-port/bank-byte scheme compatible with Cromemco and Alpha Microsystems.

BFCCS2032	*Assembled & Tested*		$500.00

S-100 MAINFRAME

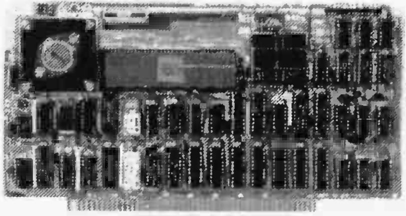
12-slot motherboard with removable termination card

BFCCS220001	*Office Cream*	35 lbs.	$575.00
BFCCS220002	*Blue*	35 lbs.	$575.00

SEND $1.00 TODAY FOR THE NEW, FULL COLOR SPRING 1982 ENGINEERING SELECTION GUIDE!

DUAL

1 ONE



CPU BOARDS

CPU/68000 - 8MHz 68000 CPU

16 bit 68000 CPU with on board ROM containing MACSBUG Monitor or Motorola 68541 Memory Management Unit (MMU).

Part No.	Description	List Price	Our Price
BFDULCPU68000	*A&T with Monitor*	$1195.00	$1075.00
BFDULCPU68000M	*A&T with MMU*	$1495.00	$1395.00

MEMORY BOARDS

DMEM256KP-256K DYNAMIC MEMORY MODULE

256Kb with byte parity error detection for 8 or 16 bit computers

BFDULDMEM256	*256K A&T*	$1495.00	$1395.00

CMEM NONVOLATILE CMOS MEMORY

Nonvolatile CMOS memory with 3-10 year battery backup on board.

BFDULCMEM8	*8K A&T*	$695.00	$629.00
BFDULCMEM16	*16K A&T*	$795.00	$725.00
BFDULCMEM32	*32K A&T*	$995.00	$940.00

2716/2732 EPROM BOARD WITH 16 BIT DATA PATHS

Designed to hold 32Kb of 2716 type or 64Kb of 2732 type EPROMs, or ROMs for read only use with 16 bit CPU systems.

BFDULEPROM32	2716 EPROM Board A&T	$295.00	$280.00
BFDULEPROM64	2732 EPROM Board A&T	$295.00	$280.00

REAL TIME & DATA AQUISITION

AIM 12-12 BIT A/D CONVERTER

A/D input module with 12 bit accuracy, 32 input channels and optional instrumentation amplifier

BFDULAIM12	A&T with Instrumentation Amp.	$745.00
BFDULAIM12B	A&T without Instrumentation Amp.	$660.00

AOM 12-12 BIT D/A CONVERTER

D/A output module, 4 channels, 12 bit accuracy. Optional VIC420 industrial output module (4-20Ma), 4 channels, used in conjunction with AOM12.

BFDULAOM12	*Assembled & Tested*	$675.00	$640.00
BFDULVIC420	*Assembled & Tested*	$675.00	$640.00

CLK24-NONVOLATILE CLOCK/CALENDAR

Day, date, hours, minutes, seconds, and 3-5 year battery backup on board. Read or write directly from I/O port. Jumperable for 64Hz UNIX® or real time applications.

BFDULCLK24C	*A&T w/64Hz Interrupt*	$300.00	$285.00

SOFTWARE

DIGITAL RESEARCH

BFDIRCPM	*CP/M 2.2 Control Program/ Microcomputers*	$150.00
BFDIRMAC	*MAC Macro Assembler*	$ 90.00
BFDIRRMAC	*RMAC Relocating MAC*	$200.00
BFDIRSID	*SID Symbolic Instruction Debugger*	$100.00
BFDIRTEX	*TEX Text Formatter*	$100.00
BFDIRDES	*DESPOOL Background Print Utility*	$ 50.00
BFDIRCB80	*CBASIC Programming Language*	$150.00
BFDIRCB86	*CBASIC-86 Programming Language*	$325.00

MICROPRO INTERNATIONAL

BFMOSWDSTR	*Wordstar Version 3.0*	$300.00
BFMOSMLMRG	*Mail Merge*	$100.00
BFMOSSPSTR	*Spell Star*	$150.00
BFMOSCALSTR	*Calc Star*	$200.00
BFMOSDATSTR	*Data Star*	$200.00
BFMOSSUPSET	*Supersort*	$150.00

SORCIM

BFSORSCAL	*SUPERCALC a Superior Electronic Worksheet*	$295.00
BFSORACTI	*ACT I 8080/Z80 Assembler*	$175.00
BFSORACTII	*ACT II 8086/8088 Assembler*	$175.00
BFSORTRNS	*TRANS 8086/8088 Translator*	$125.00
BFSORPM80	*PASCAL/M REL4 8080/8085/Z-80*	$395.00
BFSORPM86	*PASCAL/M 8086*	$495.00

MICROSOFT

BFMOSBAS80	*BASIC-80 Version 5.X Extended Disk Basic*	$300.00
BFMCPBASC	*BASIC Compiler Version 5.X*	$395.00
BFMOSMFT	*FORTRAN-80*	$500.00

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Circle 370 on inquiry card.

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ONE

HOW CLEAN IS YOUR POWER?

The Power Protectors SOLA

The Sola Micro/Mini Computer Ultra Isolated Regulator provides instantaneous voltage regulation, and ultra isolation from both transverse and common mode noise for any type of load. It also suppresses transients, protects against overloads and serves as a portable dedicated line. It is the ultimate in AC line conditioning equipment.

The Sola "Micro/Mini" is particularly applicable in systems involving mini or micro computers. POS equipment, microprocessors, or data terminals — where noise and transients cause errors, or low voltage and short term disruptions can result in loss of memory. The output waveshape is sinusoidal and contains less than 3% harmonic distortion, making it ideal for any electronic load.

Common mode noise rejection exceeds 120 dB for the regulator, while transverse noise rejection is better than 60 dB — true ultra isolation. Brownout protection is a real bonus feature. Input line voltage variations as great as ±15% are instantaneously regulated to a maximum output deviation of ±3%. And, the output will remain within NEMA voltage specifications for input voltages as low as 65% of nominal.

Especially designed for office type environments, the Sola "Micro/Mini" is truly portable and has a low sound level of 43 dB.

- Instantaneous regulation
- Regulator common mode noise rejection of 120 dB
- Regulator transverse mode noise rejection of 60 dB
- Completely portable — no installation costs
- Matches Micro/Mini computer packaging
- Complete isolation from pwer line - less than 3pFd
- Quiet operation — below normal office levels
- Operating range from -20°C to +50°C
- No loss of output for line loss up to 3 msec
- Line cord
- On-off switch
- Dual output receptacles

MINICOMPUTER REGULATORS

PORTABLE 120VAC 60 Hz SINGLE PHASE

Part No.	Maximum Output VA Rating	Dimensions L x W x D (Approx.)	Approx. Shipping Weight	Price List	Price Our
BFSLA6313070	70	12 x 6 x 6	10 lbs.	$186.85	$159.00
BFSLA6313114	140	12 x 6 x 6	18	$244.90	$208.40
BFSLA6313125	250	14 x 8 x 8	31	$291.00	$248.05
BFSLA6313150	500	17 x 9 x 9	47	$404.20	$344.00
BFSLA6313175	750	17 x 9 x 9	60	$515.60	$438.80
BFSLA6313210	1000	17 x 9 x 9	75	$597.20	$508.25
BFSLA6313220	2000*	17 x 11 x 11	108	$1015.60	$864.35

Output voltage is 120VAC ±3% for an input voltage of 95-130VAC
*Unit has 30 Amp twist receptacle.
Also available are Hard Wired and 50Hz Models.

MINI UPS

A mini UPS goes one step further than a minicomoputer regulator. It provides the same voltage, noise and brownout protection plus maintains power to keep equipment running smoothly during a blackout. When a power failure occurs, the internal maintenance free battery continues powering the inverter without the use of any switching devices. This provides uninterrupted, conditioned AC power to the critical load.

A true UPS always between the AC line and critical load providing complete protection from brownouts and blackouts as well as line noise and transients. Output waveshape is sinusoidal with less than 3% single harmonic and 5% total harmonic distortion. Regulated output is ±3% when operating from either AC line or battery. Handles load surges and fault clearing providing 125% overload for 10 minutes, 150% overload for 10 cycles and 200% in short circuit with 2 automatic restrikes before shutdown. Maintenance-free battery automatically rechareages upon return of AC line. Oper. Temp. 0°C to 40°C. Especially designed for small, sensitive electronic equipment such as minicomputers, data terminals, P.O.S. systems. Inplut voltage, 115VAC.

PORTABLE 120VAC 60Hz UNINTERRUPTABLE POWER SYSTEMS

Part No.	Maximum Output VA Rating /Time	Dimensions L x W x D (Approx.)	Approx. Shipping Weight	Price List	Price Ours
BFSLA260050400300	400/10Min	12x19x11	85	$1544.00	$1314.00
BFSLA260050400301	400/20Min	12x19x11	95	$1574.00	$1339.00
BFSLA260050750300	750/10Min	12x19x11	125	$1674.00	$1425.00

Also available are 220V 50Hz models of the above.

Call for all SOLA products not listed.

Dysan CORPORATION

WHY SETTLE FOR LESS?

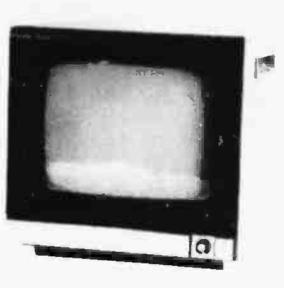
DYSAN DISKETTES have long been regarded as the standard that all others attempt to duplicate. Today, Dysan still manufactures the ultimate in flexible recording media for 5¼" and 8" flexible disk drives. Both the 5¼" and 8" diskettes are certified to be 100% error free over the entire recording surface providing you with the best insurance from data error.

5¼" DISKETTES
35/40 TRACK CERTIFIED

Part No.	Sectors	Density	Sides/ Heads	PRICE Box of 10
BFDSN1041	Soft	Single	1/1	$45.00
BFDSN10410	Soft	Double	1/1	$50.00
BFDSN10510	16 Hard	Double	1/1	$50.00
BFDSN10710	10 Hard	Double	1/1	$50.00
BFDSN10420	Soft	Double	2/2	$60.00
77/80 TRACK				
BFDSN20520	16 Hard	Double	2/2	$80.00
8" DISKETTES				
BFDSN37401	Soft	Single	1/1	$55.00
BFDSN374010	Soft	Double	1/1	$65.00
BFDSN374020	Soft	Double	2/2	$85.00

SANYO

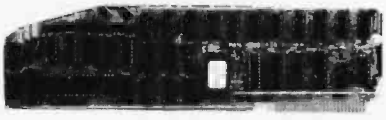
FCC CLASS 2 APPROVED DATA DISPLAY MONITORS



Part No.	Description	List Price	SALE
BFSYOVM4509	9"B&W P4, 10MHz (15 lbs.)	$215.00	$169.00
BFSYOOM4509CX	9"Green, P31, 10MHz (15 lbs.)	$200.00	$180.00
BFSYOOM8012C	12"B&W P4, 18MHz (24 lbs.)	$250.00	$225.00
BFSYOOM8112CS	12"GReen, P31, 18MHz (24 lbs.)	$260.00	$235.00
BFSYOVMC6013	13"Color, 16 x 64 (35 lbs.)	$470.00	$425.00
BFSYOOM6113*	13"RGB Color (35 lbs.)	$995.00	$895.00

**As used with IBM P.C.*

Vista APPLE II® PERIPHERALS



A800 DOUBLE DENSITY 8" DISK CONTROLLER

- High Speed DMA TRansfer of Data (1 Microsecond/Byte)
- Uses All Standard Apple DOS Commands (OPEN CATALOG, LOCK, DELETE, LOAD...etc) Except for INIT Which Has Been Improved and Enhanced in a Vista Format Routine
- Compatible with Apple DOS 3.2/3.3, Pascal 1.1 and CPM 2.2 (With the Z80 Soft Card by Microsoft)
- Interfaces to All Shugart/ANSI Standard Eight-Inch Floppy Disk Drives
- 2Kx8 PROM Contains Autoboot Functions and All 8" Floppy Driver Code Allowing Complete Memory Usage Map Compatibility w/Apple DOS 3.2/3.3

BFVISA800	Controller and disk	$595.00	$499.00
BFVIS0180	Vision 80 80 x 24 Display Card	$395.00	$349.00
BFVIS0104	Vision 40 - 40 Column, upper/ lower case enhancement	$195.00	$175.00

TEI MicroFrame®

110V 60Hz CVT Mainframes, the best money can buy!
12 Slot ±8V 17±16V @2A
22 Slot±8V @ 30A± 16V @ 4A

PART NO.	DESCRIPTION	LIST PRICE	OUR PRICE 1-9	OUR PRICE 10-24
BFTEIMCS112	12 Slot Desk	$755.00	$660.00	$627.00
BFTEIMCS122	22 Slot Desk	$910.00	$798.00	$776.00
BFTEIRM12	12 Slot Rackmount	$800.00	$715.00	$681.00
BFTEIRM22	22 Slot Rackmount	$965.00	$860.00	$825.00

Shipping Weight: On 12 Slot Mainframes: 45 lbs.
On 22 Slot Mainframes: 55 lbs.

S-100 MAINFRAME WITH 12 SLOT MOTHERBOARD AND CUTOUTS FOR 3 - 5¼" FLOPPY DISK DRIVES

+8V @ 17A ±16V @ 2A +12V @ 1.2A Internal Power Cable

BFTEITF12	12 Slot desk	$745.00	$670.00	$638.00
BFTEIRF12	12 Slot Rackmount	$855.00	$765.00	$732.00

Shipping Weight: On 12 Slot Desk: 40 lbs.
On 12 Slot Rackmount: 45 lbs.

DUAL 8" DISK DRIVE CHASSIS

For two Shugart 801R or two Qume DT-8 size drives
with internal power cables provided
+24V @ 1.5A +5V @ 1.0A - 5V @ .25A

BFTEIDF00	Desk Top	$565.00	$520.00	$480.00
BFTEIRF00	Rackmount	$725.00	$650.00	$630.00

Shipping Weight: On Desk Top: 40 lbs.
On Rackmount: 45 lbs.

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THE STAR
OUR MOST POPULAR MODEM
We've Sold Thousands!

• 0 to 300 baud • Bell 103 and 113 • Exclusive triple seal acoustic chamber • Self Test • ±0.3% frequency stability: crystal controlled • Receiver Sensitivity of -50dB on, -53dB off • FSK Modulation • RS232 Compatible • **Switches:** Originate/Off/Answer, Full Duplex/Test/-Half Duplex • **Indicators:** Transmit Data, Receive Data, Carrier Ready, Test

Part No.	Description	List Price	SALE
BFPRNSTAR	RS232, TTL 20Ma Current Loop	$199.00	$129.00

Hayes™

SMARTMODEM

• Auto Answer, Auto Dial, Full or Half-Duplex, Loop Back • Serial binary, and asynchronous data formats with 7 or 8 data bits, 1 or 2 stop bits: odd, even or no parity • 0-300 baud • RS232C interface • Z8 Microprocessor with 2Kb control program • 40 character command buffer • Size: 1.5" x 5.5" x 9.6"

BFOCH0200P	Smartmodem (Sh. Wt. 6 lbs.)	$279.00	$249.00
BFOCH0300P	Chronograph (Sh. Wt. 3 lbs.)	$249.00	$219.00
BFOCH0100P	Micromodem 100 (Sh. Wt. 4 lbs.)	$399.00	$369.00
BFOCH29010	CP/M* 8" Terminal Program for above		$ 25.00
BFOCH0000P	Micromodem II	$379.00	$329.00
BFOCH24010	Datacom (PASCAL patch) for above		$ 50.00

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FUJITSU & NEC

LETTER QUALITY PRINTERS FROM SELLUM

Interfaces: • RS232C and Current Loop • Centronics type parallel interface • IEEE/488 All are DIP switch selectable.
Personality Protocols: • NEC5510 • DIABLO 630 • QUME Sprint 9 • IBM Personal Computer • ATARI (Centronics 737).
Special Features: • Z80 CPU • 12K ROM • Standard 16K Buffer • Optional 48K Buffer • 50 - 19.2K baud • Micro-coded alarm differentiates error conditions with pulse combinations • Intelligent bi-directional printing with logic seeking • Complete word processing features • Self test • Auto reprint • Auto clear error • Proportional spacing • Supports Automatic justification • Complete Vector plotting routines • Sheet feeder mode allows easy interface to most mechanical sheet feeders • 6 month warrantee • Quiet - 60db • Front panel forms control • Universal power supply 115/220V 50/60 Hz.

80 CPS USING THE FUJITSU SP830

Part No.	Description	List Price	Our Price
BFSLMF86	*Intelligent Printer*	*$3495.00*	$2995.00

OPTIONS

BFSLMF86VFT	*Vertical forms tractor*	$200.00
BFSLMF8648K*	*48K RAM buffer*	$400.00

Call for pricing on sheet feed options

55 CPS USING THE NEC 7700

BFSLMN77	*Intelligent Printer*	*$3295.00*	$2895.00

OPTIONS

BFSLMN77VFT	*Vertical Forms Tractor*	$ 230.00
BFSLMN77BOFT	*Bidirectional Forms Tractor*	$ 400.00
BFSLMN77CSF	*NEC Cut Sheet Feeder*	$1595.00
BFSLMN77CSF2	*Twin Cut Sheet Feeder*	$2150.00
BFSLMN7748K*	*48K RAM Buffer*	$ 400.00

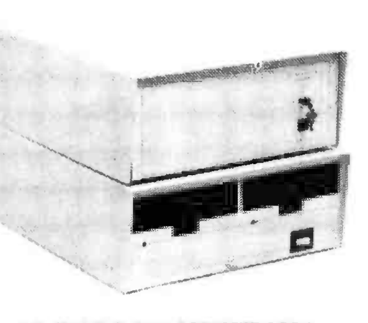
**Must be ordered with the printer*

INTERFACE CABLES

BFCPAM572	*Centronics IBM/NEC Cable*	$80.00
BFSCOB251	*RS232C Serial Cable*	$60.00

Call for other cables not listed

Para Dynamics



18 SLOT S-100 MAINFRAME

CVT Power Supply, forced air cooling; security lock 120 or 220V AC at 50 or 60Hz+8V@20A, ±16@3.5

BFPON20180	*Desk Top*	*$799.00*	$699.00
BFPON2018R	*Rack Mount*	*$849.00*	$749.00

8 SLOT S-100 MAINFRAME WITH CUTOUTS FOR 2 5¼" DISK DRIVES

+5@5A, -5@500MA, +8@15A, +12@6A, +16@2, -16@2

BFPON2508D	*Desk Top*	*$899.00*	$789.00
BFPDN2508R	*Rack Mount*	*$949.00*	$839.00

DISK DRIVE FACILITY

Accommodates two 8" floppy drives, of Shugart, Qume, or similar design and dimensions. 110 or 220V AC at 50 or 60Hz CVT power.

BFPDN2200D	*Desk Top*	*$659.00*	$579.00
BFPON2200R	*Rack Mount*	*$679.00*	$595.00

PRONTO

Free standing cabinet. Will accept 2, 8" Floppy disks and 1, 8" Rigid disk. 18 slot card cage will accept the double height 10" x 10" S-100 cards (Alpha Micro and others) CVT Power Supply.

+24@7A, +16@2.2A, -16@3.5A, +8@20A, +5@5A

BFPDN2818	*PRONTO*	*$1295.00*	$1129.00

PRONTO COMPLETE WITH POWER SUPPLY POWER-UP SEQUENCER

BFPON2818S	*with sequencer*	*$1395.00*	$1249.00

Shipped motor freight collect

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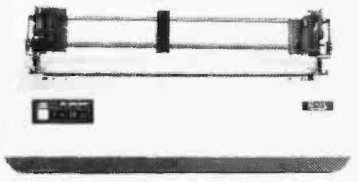


- *BI-DIRECTIONAL-120 CPS* • *Parallel and Serial I/O*
- *9x9 Matrix (Alphanumeric)* • *100 Thru 1200 Baud*
- *6x9 or 12 matrix for graphics* • *Self Test*
- *5,8.3,10,16 Characters p/Inch* • *Out of paper switch*
- *6 or 8 Lines per Inch* • *Friction or Tractor Feed*
- *80 CPL@10 CPI for 82A* • *3" to 14" Top of form (Switch Selectable)*
- *132 CPL@10 CPI for 83A & 84* • *10 Different Character Sets*

The above printers come complete with friction and tractor feed. Front panel selection of 10 different form lengths. Front or bottom paper loading for up to 4 part forms and tear bar. All three printers have a parallel interface as standard. The 82A and 83A also include a 1200 baud serial interface as standard.

Part No.	Description	List Price	SALE
BFOKIDAT82AT	80 column printer w/tractor (25 lbs.)		$539.00
BFOKBFRAPH82	High resolution graphics ROM 60x66		$ 75.00
BFOKIDAT83AT	132 column printer w/tractor (35 lbs.)		$750.00
BFOKIGRAPH83	High resolution graphics ROM 60x66		$ 75.00
BFOKISER2KBF	9600 Baud 2K serial buffer interface		$149.00
BFOKIDAT84AP	132 col. printer parallel interface with graphics (35 lbs.)		$1095.00
BFOKIDAT84AS	132 Col. printer 9600 baud serial 2K interface with graphics (35 lbs.)		$1250.00
BFMBSAPLINTWC*	Apple Parallel Interface w/cable (1 lb.)		$ 75.00

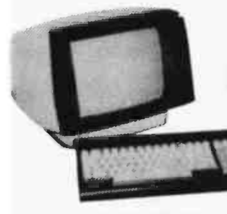
**Sold only with printers*

EPSON

BFEPNMX80	80 col./CPS tractor feed (17 lbs.)	$450.00
BFEPNMX80FT	with Tractor/Friction feed (20 lbs.)	$550.00
BFEPNMX100	132 col./80CPS (30 lbs.) Tractor/Friction Feed	$725.00
BFMBSAPLINTWC*	Apple parallel interface with cable	$ 75.00
BFMBSEI1*	Serial interface for EPSON Printers	$ 59.00

**Sold only with printers*

ADDS
Applied Digital Data Systems Inc.



SALE! $525.00

VIEWPOINT — ADDS

Detachable keyboard, RS232 interface and auxiliary port. 80 x 24 display, tiltable screen.

BFADDVWPR	*Sh. weight: 30 lbs.*	*$699.00*	$525.00

DISK CABINETS

V-100 - VISTA

• *Desk or rack mountable* • *Internal power and data cables* • *Drives pull out for easy service and maintenance*

BFVISV100	*Disk Drive Cabinet (43 lbs)*	*$495.00*	$449.00

SINGLE 8" - Q.T.

Single 8" cabinet with power supply

BFQTCOOC8	*(22 lbs.)*	*$249.00*	$225.00

DUAL 8" - Q.T.

Dual 8" cabinet with power supply

BFQTCDDC88	*(24 lbs.)*	*$395.00*	$349.00

5" CABINETS - VISTA

BFVIS9801	*Single 5" with P.S.*	$ 85.00
BFVIS9802	*Dual 5" with P.S.*	$110.00

Overseas Customers Send $4.00 U.S. Currency or 22 International Reply Coupons to Receive Our New Catalog by Airmail

Tandon

Tandon TM-800 Thinline is exactly half the size of conventional 8" floppy disk drives.

Exactly one-half the height of any other model.
Proprietary, high-resolution, read-write heads patented by Tandon
D.C. only operation - no A.C. required
Industry standard interface.
Three millisecond track-to-track access time *(9 lbs.)*

BFTNDTM8481	*Single Sided* $425.00	2 or more	$395.00
BFTNDTM8482	*Double Sided* $575.00	2 or more	$550.00
BFTNDTM8M	*Manual - not included with drive*		$ 10.00

TANDON 5¼" DRIVES

BFTNDTM1001	*Single Sided, 250KB (5 lbs.)*	$249.00* ea
	2 or More $220.00	
BFTNDTM1002	*Double Sided, 500KB*	$325.00 ea.
	2 or More $299.00	
BFTNOTM1003	*Single Sided, 500KB*	$325.00 ea.
	2 or More $299.00	
BFTNOTM1004	*Double Sided, 1000KB*	$449.00 ea.
	2 or More $420.00	
BFTNOTM5M	*manual, not included with drive*	$ 10.00

**As used in the IBM P.C.*

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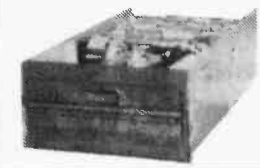

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8", Double-sided, double-density, interchangeable with QUME & Shugart

BFMITM289463	*Sh. Weight 16 lbs.*	$550.00
BFMITM289463M	Manual	$ 10.00

2 or More $525.00 each

Shugart 801R

Single sided, double density - most popular 8" drive

BFSHU801R	*$425.00 ea. or 2 or more (16 lbs) for*	$395.00 ea.
BFSHUSA801RM	*Manual for 801R drives*	$ 10.00

INTERNATIONAL INSTRUMENTATION, INC.

UNIVERSAL DISK ENCLOSURES

• *Accepts any combination of 8" drives (QUME/Shugart 801R type or ½ size Tandon type)* • *Also accepts hard disks* • *Positive pressure* • *Optional Disk environment monitor shows supply voltage and internal cabinet temperature* • *Internal power and data cables provided.*

UNIVERSAL DRIVE CABINET complete with power supply, fan and filter, and all internal cables for attachment of two 8" floppy drives.

BFIIIUDE004	Dual Drive Cabinet (Sh. Wt. 40 lbs)	$495.00	$450.00
BFIIIUDE004EM	w/Environmental Monitor installed	$584.95	$535.00
BFIIIUDE004AUG	Dual Drive cabinet with Augmentation power suply module to increase 5V supply from 6 amps to 9 amps for use with two hard disks or 4 Tandon drives. Also includes Disk Environment Monitor (45 lbs.)	$733.00	$650.00
BFIIIUDERCK	19" Rack Mount kit UDE004		$ 89.95

THIN THREE DRIVE CABINET complete with power supply, and all internal cables for attachment of three thin 8" floppy drives (Tankdon type). One AC power connector is also provided for use with full size drive.

BFIIIUDETT	Three Drive Cabinet (Sh. Wt. 35 lbs)	$495.00	$450.00
BFIIIUDETTTEM	with Environmental Monitor installed	$584.95	$535.00

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Circle 371 on inquiry card.

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FLUKE®

NEW 4½ DIGIT HANDHELDS!

The FLUKE 8060A and 8062A offer the most powerful combination of capabilities ever in a handheld DMM, including these:

- 4½ digit resolution
- 10 µ V, 10mA, 10M sensitivity
- 100KHz True RMA (8060A)
- 30KHz True RMS (8062A)
- Relative Reference
- Constant current diode test
- Self diagnostics
- Basic DC accuracy of 0.04% (8060A); 0.05% (8062A)

The 8060A also offers dBm, relative dB, frequency measurements to 200KHz. Auto ranging megohms to 300k Ω, and conductance (2000 nS).

BFFLU8060A	with safety designed test leads	**$349.00**
BFFLU8062A	with safety designed test leads	**$279.00**

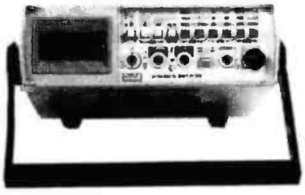
3½ DIGIT HANDHELDS: THE WORLD STANDARD

11 functions:

- dc voltage
- ac voltage
- dc current
- ac current
- resistance
- diode test
- conductance
- high-speed continuity beeper
- temperature (via K-type thermocouple
- peak hold on voltage and current functions 0.1% basic dc accuracy (8024B & 8020B) 0.25% basic dc accuracy (8021B & 8022B)
- visual logic level detection and continuity indicators

Extensive overload 3½-digit resolution protection with 600V double-fused current input. Safety-designed test leads. Two-year parts and Two-year labor warranty. Calibration Cycle.

BFFLU8024B	(All 11 functions)	**$239.00**
BFFLU8020B	(First 8 functions)	**$189.00**
BFFLU8021B	(First 7 functions)	**$149.00**
BFFLU8022B	(First 6 functions)	**$139.00**



8010A/8012A. Measurement versatility on the bench

7 functions

- dc voltage
- ac voltage
- dc current
- ac current
- resistance
- diode test
- conductance

10 amp current range (8010A)

2 Ω and 20 Ω resistance ranges (8012A)

True RMS ac measurements

3½-digit resolution

0.1% basic dc accuracy

Holds voltage, resistance and conductance readings via 80T-H Touch Hold Probe

Extensive overload protection with 600V double-fused current input

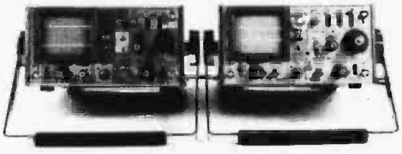
The 8050A. 4½ digits of unique function and features above 7 features, plus:

- 16 selectable reference impedances
- Relative reference/offset
- 4½-digit resolution
- dBm (measuring ac and dc voltage)
- 0.03% basic dc accuracy

BFFLU8050A	4½ digit True RMS Bench DMM	**$369.00**
BFFLU8050A01	with Ni-Cad battery option	**$419.00**
BFFLU8010A	10 amp True RMS Bench DMM	**$259.00**
BFFLU8010A01	8010A with Ni-Cad battery option	**$299.00**
BFFLU8012A	Low-Ohms TrueRMS bench DMM	**$339.00**
BFFLU8012A01	8012A with Ni-Cad Battery Option	**$379.00**

The shipping weight on bench DMM is 5 lbs.; 5 lbs. with Ni-Cad Battery Option

HITACHI
Hitachi Denshi, Ltd.



Buy with confidence from the nation's largest HITACHI distributor

Single and dual trace, 15 thru 100 MHz. All high sensitivity Hitachi oscilloscopes are built to demanding Hitachi quality standards and are backed by a 2-year warranty. They're able to measure signals as low as 1mV/division (with X5 vertical magnifier). It's a specification you won't find on any other 15 or 30 MHz scopes. Plus: Z-axis modulation, trace rotation, front panel X-Y operation for all scope models, and X10 sweep magnification. And 30 thru 100 MHz oscilloscopes offer internal signal delay lines. For ease of operation, functionally related controls are grouped into three blocks on the color coded front panel. Now here's the clincher: For what you'd expect to pay more, you actually pay less. Check our scopes before you decide. All scopes complete with probes.

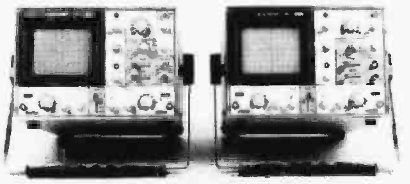
NEW! FIELD SERVICE PORTABLES

BFHITV209
20MHz Dual Trace
w/2 hour Battery Backup
List Price: $995.00
Our Price: $859.00

- 20 MHz, Dual Trace
- 3.5" Rectangular CRT with Internal Graticule
- Battery Operated
- Only 4.3" High by 8.5" Wide
- 1 mV Sensitivity (to 5 MHz)

BFHITV509
50MHz Dual Trace
w/Calibrated Variable Delay
List Price: $1895.00
Our Price: $1749.00

- 50MHz, Dual Trace
- Calibrated Delayed Sweep
- 3½" 12KV CRT w/internal graticule
- Lightweight - 11 lbs.
- Operates on Battery Pack (optional)
- 1 mV Sensitivity (to 10 MHz)



BFHIT-V352
35MHz Dual Trace
WITH DELAY
List Price: $1150.00
Our Price: $ 859.00

Economically priced dual trace oscilloscope

Square CRT with internal graticule (illuminated scale)

High-accuracy voltage axis & time axis set at #3% (certified at 10° to 35°C)

High-sensitivity 1mV/div. Low drift

2 Year Warranty

BFHIT-V202
20MHz Dual Trace
List Price: $850.00
Our Price: $695.00

Dynamic range 8 div.

TV sync separator circuit

Built-in signal delay line (V-352)

X-Y operation

Sweep-time magnifier (10 times)

Trace rotation system

Fine adjusting, click-positioning function

50MHz & 100MHz

DUAL TRACE WITH CALIBRATED TIME DELAY

BFHITV550B
50MHz
with 3rd Trace
Trigger View
List Price: $1745.00
SALE
$1495.00

- Large, Bright 8 x 10cm screen
- High sensitivity 1mv/div (10MHz)
- 5 ns/div Sweep Rate
- 3rd channel display (Trigger View)
- Variable trigger hold-off
- Full TV Triggering
- Single Sweep
- Automatic Focus Correction

BFHITV1050
100MHz
with 3rd & 4th Trace
Trigger View
List Price: $2390.00
SALE
$1995.00

- Large, bright 8 x 10 cm screen
- Quad Trace Operation (Ch1, Ch2, A Trigger and B trigger)
- high sensitivity 500 µ v/div(5MHz)
- High-accuracy ±2% (+10 to +35°C)
- Alternate Timebase Operation
- 20MHz Bandwidth Limiter
- Full TV Triggering

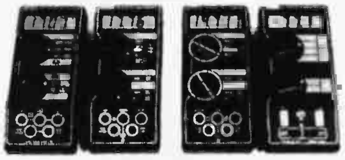
BFHITV302B DUAL TRACE 30MHz w/delay

List Price: $995.00 **Our Price: $795.00**

BFHITV152B DUAL TRACE 15MHz (no delay)

List Price: $735.00 **$Our Price: $595.00**

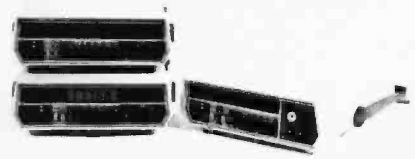
KEITHLEY



Handheld DMMs For Every Application and Budget

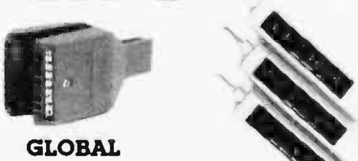
- dc voltage
- ac voltage
- dc current
- ac current
- Resistance
- Diode Test
- Easy-to-use Rotary Switches
- Large 0.6" LCD displays
- 3½ or 4½ digit accuracy
- Overload protection
- Externally accessible battery & fuse
- Rugged 0.1" ABS Plastic Case
- Shock-Mounted PC Board

BFKTH130	±0.5% DCV accuracy, 10MΩ input impedence auto polarity and current measurement through 10A	**$124.00**
BFKTH131	Same as BFKTH130 except 0.25% accuracy and enhanced band with on top ACV ranges	**$139.00**
BFKTH128	See/hear display includes both over/under threshold indicator arrows, audible tone that operates on all ranges & functions, and adjustable threshold	**$139.00**
BFKTH135	4½ digit, 0.05% accuracy	**$239.00**
BFKTH871	Thermocouple (TC) based thermometer	**$199.00**
BFKTH1304	Soft Carrying Case & Stand (handhelds)	**$ 10.00**
BFKTH1306	Deluxe Carrying Case (handhelds)	**$ 25.00**



Bench DMMs: Solid Price/Performance Values

BFKTH169	0.25% DCV 3½ digit LCD display	**$189.00**
BFKTH176	0.05% DCV 4½ digit LCD display 20kHz bandwidth on lower ranges	**$269.00**
BFKTH179A	0.04% DCV 4½ digit LED display 20A capability TRMS ACV	**$359.00**
BFKTH1792	BCD Output Option for BFKTH179A	**$189.00**
BFKTH1793	IEEE Interface for BFKTH179A	**$325.00**



GLOBAL SPECIALTIES LOGIC PROBES

SPECIFICATIONS

MODEL	LP1	LP2	LP3
Response	50 ns. 80 ns single-shot event, 10MHz pulse train	300 ns. 1.5 MHz pulse train	6 ns typical tested at 10 ns 70MHz pulse train
Pulse Mode	High Speed Trainor Single Event		

Part No.	Description	List Price	Our Price
BFGSCLP1	Standard 10MHz w/Memory	$50.00	**$45.00**
BFGSCLP2	Economy 1.5MHz	$32.00	**$30.00**
BFGSCLP3	High-Speed 50MHz w/Memory	$77.00	**$69.00**
BFGSCLP4	100MHz + ECL Logic Probe	$150.00	**$136.00**
BFGSCDP1	High-speed digital pulser. 100 PPS or Single-Shot	$83.00	**$76.00**

16 AND 40 CHANNEL LOGIC MONITORS

LM1 clips over any DIP IC up to 16 pins. Each of its 16 contacts connects to a single bit level detector that drives a high intesnity, numbered LED readout activated when the applied voltage exceeds a fixed 2 V threshold. Logic "1" turns LED on; logic "0" keeps LED off.

BFGSCLM1	**$79.00**	**$72.00**

LM-4 will instantly and clearly display the logic states of any digital IC of up to 40 pins or any of up to 40 independent circuit points when used with its standardly supplied connector cable terminated with a 40-pin IC test clip

BFGSCLM4	$199.00	**$189.00**

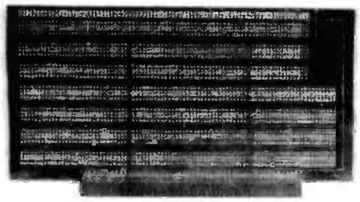
LOGICAL ANALYSIS KITS

BFGSCLTC1	LP1, DP1 & LM1 in molded case	$240.00	**$220.00**
BFGSCLTC2	LP3, DP1 & LM1 in molded case	$270.00	**$245.00**

Circle 372 on inquiry card.

PRIORITY ONE ELECTRONICS

page NC Drilled Boards



Page's NC* DRILLED Printed Circuit Boards offer you benefits not currently available from a conventional *punched* board. If you are involved in professional prototyping of PC boards, you know that a "clean" prototype is always more representative of what you can expect in your final *production* board. AND isn't that what prototyping is all about? **If you Want the Best . . . Ask for PAGE!**

SPECIFICATIONS:

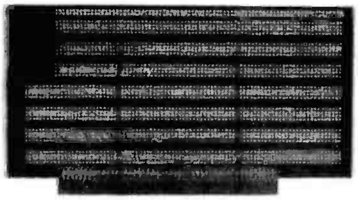
UL Approved.

Material: .062" (1.57mm) thick FR-4 epoxy glass laminated copper per MIL-T-55561 Type GF.

Hole Diameter: .042" NC drilled.

Plating: Circuitry: Electrolers tin 50 x 10-6 in.
Contact fingers: .0010" gold over .0050" nickel.
Contact fingers are chamfered for ease of insertion.

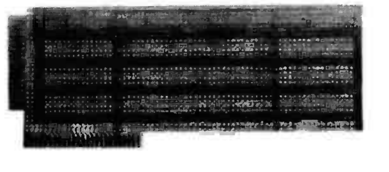
S-100 BOARDS



P1002 Component Side

PART NO.	DESCRIPTION	PRICE 1-4	5-9	10-24
BFPGBP1001	S100 Bare Board	$15.95	$13.95	$11.95
BFPGBP1002	S100 Horizontal Busses	$22.95	$19.95	$17.95
BFPGBP1003	S100 Vertical Busses	$22.95	$19.95	$17.95
BFPGBP1004	S100 Pads Per Hole	$23.95	$20.95	$18.95

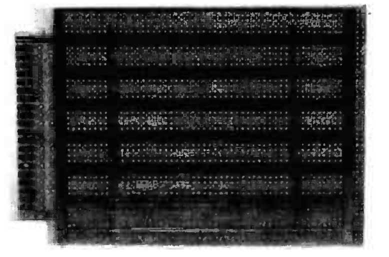
APPLE BOARDS



P5002 Component Side

BFPGBP5001	Apple Bare Board	$15.95	$13.95	$11.95
BFPGBP5002	Apple Horizontal Busses	$22.95	$19.95	$17.95
BFPGBP5004	Apple Pads Per Hole	$23.95	$20.95	$18.95

GENERAL PURPOSE PLUGBOARDS



P4413 Wiring Side

BFPGBP4411	4.5"x6"	22/44 .156"	Bare Board	$ 9.95	$ 8.95	$ 7.95
BFPGBP4413	4.5"x6"	22/44 .156"	Vertical Buss	$13.95	$12.50	$11.50
BFPGBP4414	4.5"x6"	22/44 .156"	Pads Per Hole	$14.95	$13.50	$12.50
BFPGBP4421	4.5"x9.6"	22/44 .156"	Bare Board	$10.95	$ 9.95	$ 8.95
BFPGBP4423	4.5"x9.6"	22/44 .156"	Vertical Buss	$14.95	$13.50	$12.50
BFPGBP4424	4.5"x9.6"	22/44 .156"	Pads Per Hole	$15.95	$14.50	$13.50
BFPGBP7211	4.5"x6"	36/72 .1"	Bare Board	$ 9.95	$ 8.95	$ 7.95
BFPGBP7213	4.5"x6"	36/72 .1"	Vertical Buss	$13.95	$12.50	$11.50
BFPGBP7214	4.5"x6"	36/72 .1"	Pads Per Hole	$14.95	$13.50	$12.50
BFPGBP7221	4.5"x9.6"	36/72 .1"	Bare Board	$10.95	$ 9.95	$ 8.95
BFPGBP7223	4.5"x9.6"	36/72 .1"	Vertical Buss	$14.95	$13.50	$12.50
BFPGBP7224	4.5"x9.6"	36/72 .1"	Pads Per Hole	$15.95	$14.50	$13.50

RS232 and "D" SUB-MINIATURE CONNECTORS

SOLDER TYPE

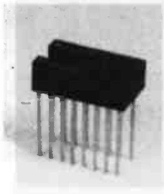
P=Plug, Male Type — S=Socket, Female Type — C=Cover, Hood

PART NO.	DESCRIPTION	PRICE 1-9	10-24	25-99
BFCNDDE9P	9 Pin Male	$ 2.10	$ 1.90	$1.70
BFCNDDE9S	9 Pin Female	$ 2.70	$ 2.40	$2.10
BFCNDDE9C	9 Pin Cover	$ 1.50	$ 1.25	$1.10
BFCNDDA15P	15 Pin Female	$ 2.75	$ 2.45	$2.15
BFCNDDA15S	15 Pin Female	$ 3.95	$ 3.60	$3.20
BFCNDDA15C	15 Pin Cover	$ 1.50	$ 1.30	$1.10
BFCNDDA25P	*25 Pin Male*	$3.00	$2.75	$2.25
BFCNDDA25S	*25 Pin Female*	$4.00	$3.75	$3.00
BFCNDDB51212	1 Pc. Grey Hood	$ 1.60	$ 1.45	$1.30
BFCNDD25H	2 Pc. Grey Hood	$ 1.50	$ 1.25	$1.10
BFCNDDB51226	2 Pc. Black Hood	$ 1.90	$ 1.65	$1.45
BFCNDDC37P	37 Pin Male	$ 5.80	$ 5.10	$4.45
BFCNDDC37S	37 Pin Female	$ 8.70	$ 7.70	$6.70
BFCNDDC37C	37 Pin Cover	$ 1.80	$ 1.55	$1.30
BFCNDDD50P	50 Pin Male	$ 8.75	$ 7.75	$6.70
BFCNDDD50S	50 Pin Female	$11.65	$10.25	$8.90
BFCNDDD50C	50 Pin Cover	$ 2.00	$ 1.80	$1.60
BFCND20418	Hardware Set 2/Pr RS232, DB25P, EIA	$ 1.00	$ .80	$ .70
BFCNORS2328F	Class 1 Cable 8 Con 8 Ft	$19.95	$17.95	$15.95
BFCN0573036	Cent. 700 Series/ Epson Printer Conn.	$ 9.00	$ 7.50	$6.00
BFIOC5730860	IDC Version of Above	$ 9.95	$ 9.00	$8.00

CALL FOR IDC "D" CONNECTOR

ROBINSON NUGENT, INC.

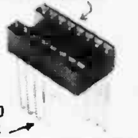
ICN SERIES GOLD 3 LEVEL WIRE WRAP SOCKETS



- 10 in GOLD Plated Pins
- Deep Chamfered Closed Entry Contacts
- RN Slide Wipe Contact Design
- Phosphor Bronze Contact Material
- Terminal Barbs Allow Self-lock Into PC Board
- Rugged Socket Body Design
- Deep Chamfered Closed Entry Contacts

PART NO.	PINS	STANDARD PCKGE.	PRICE EACH	10-24	25-99	100-249	250-999
BFRNS08WWG	8	52	.60	N/A	.49	.45	.41
BFRNS14WWG	14	30	.75	.70	.65	.55	.48
BFRNS16WWG	16	26	.85	.75	.70	.60	.52
BFRNS18WWG	18	23	1.00	.90	.80	.75	.71
BFRNS20WWG	20	21	1.20	1.05	.96	.91	.87
BFRNS22WWG	22	19	1.35	1.25	1.15	1.05	.99
BFRNS24WWG	24	17	1.35	1.25	1.15	1.05	.99
BFRNS28WWG	28	15	1.70	1.55	1.40	1.34	1.25
BFRNS40WWG	40	10	2.20	2.05	1.85	1.60	1.50

*MINIMUM ORDER $1.00 per line item. To receive quantity prices beyond 1st column you must order EXACT multiples of STANDARD PACKAGES.



NEW!

SELECTIVE PLATED PINS THAT WILL SAVE YOU MONEY BY HAVING GOLD ONLY WHERE IT COUNTS!
Same as above except pins are selectively plated.

BFRNS08TWW	8	52	.55	N/A	.45	.41	.37
BFRNS14TWW	14	30	.65	.55	.50	.47	.44
BFRNS16TWW	16	26	.75	.65	.52	.51	.46
BFRNS18TWW	18	23	.90	.79	.75	.70	.65
BFRNS20TWW	20	21	1.10	.95	.91	.87	.82
BFRNS22TWW	22	19	1.25	1.15	1.05	.94	.89
BFRNS24TWW	24	17	1.25	1.15	1.05	.96	.89
BFRNS28TWW	28	15	1.50	1.45	1.35	1.25	1.15
BFRNS40TWW	40	10	2.00	1.80	1.60	1.40	1.30

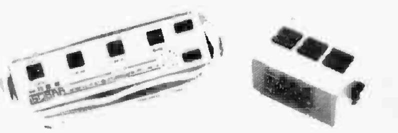
*MINIMUM ORDER $1.00 per line item. To receive quantity prices beyond 1st column you must order EXACT multiples of STANDARD PACKAGES.

SEND $1.00 TODAY FOR THE NEW FULL COLOR, SPRING 1982 ENGINEERING SELECTION GUIDE

PROTECT YOUR INVESTMENT
PROTECT YOUR DATA WITH

GSC ISOBAR ONE

With Built-In Noise Filters and Surge Suppressors



ISOLATES SENSITIVE AND VALUABLE EQUIPMENT FROM: Equipment interaction - Damaging High Voltage Spikes - AC line noise and hash.
PROTECTS AGAINST: Voltage transients caused by lightning, contact switching, turn-off of inductive components, noise due to electromagnetic coupling.
USE THE GSC ISOBAR TO ISOLATE: Microprocessor from peripherals - Lab instruments from noisy equipment - Sensitive pre-amp or tape deck from power amplifier.
THE GSC ISOBAR ELIMANATES: Equipment interaction - Equipment damage from power line spikes and surges - Errors - False printouts - Disk Skips - Audio or video hash
FEATURES: Inductive isolated ground - Sockets indivdually filter isolated - Circuit breaker protected at 15A.
VOLTAGE TRANSIENT SPIKE PROTECTION: 2000 A peak for up to 6 Sec duration spikes. 1000A, 8/20 Sec protection from repeated spikes.
LOAD HANDLING: 1875 W max. total load; 15A per socket.
INPUT: 125 VAC, 15 amps; standard 3-prong plug.

IBAR 3 - Three common outlets built-in circuit breaker, pilot light, hang-up bracket and a 6-foot cord.

		Usl Price	Our Price
BFGOFIBAR3	Sh. Wt. 3 lbs.	$59.95	$42.00

IBAR 46 - Four independently isolated outlets. Built-in 15A circuit breaker, pilot light, switch, and 6-foot cord.

BFGOFIBAR46	Sh. Wt. 4 lbs.	$79.95	$49.95

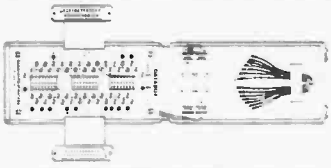
IBAR 86 - 8 outlets, grouped to form 4 independently isolated sets of two. Built-in 15A circuit breaker, on/off switch, pilot light.

BFGOFIBAR86	Sh. Wt. 5 lbs.	$84.95	$54.95

IBAR 9RM - Eight rear-mounted outlets grouped to form four independently isolated sets of two, plus one non-isolated convenience outlet on front face. 19" rack mount cabinet. Built-in 15A circuit breaker, pilot light, on/off switch, and 6-foot cord.

BFGOFIBAR9RM	Sh. Wt. 6 lbs.	$99.95	$74.95

RS232 Breakout Box



A must for every technician, repair man or systems integrator

Databox is contained in a tough, plastic case and is powered by two, 1.5 volt penlight batteries. No power is consumed by the tester when not in use. Dimensions: 2.9"x5.55"x1.45". Weight: 10 oz. w/batteries.

BFONW232BOX	$199.00	$159.00

MICROCOMPUTER PRODUCTS

MEMORY

PART NO.	PRICE
BF4116AC20	8/$18.00
BF2016P3	8/$72.00
BF2114N3L	8/$28.00
BF5257N3L	8/$50.00
BF2732	8/$96.00
BF2716	8/$48.00
BF2708	8/$20.00

Z80 SERIES

BFZ80A	$13.39
BFZ80AP10	$11.19
BFZ80ACTC	$11.19
BFZ80ADMA	$33.39
BFZ80AS100	$39.95
BFZ80AS101	$39.95
BFZ80AS102	$39.95

UARTS

BFAY51013A	$5.95
BFTR1602B	$4.95
BFTR1863	$6.95
BFIM6402	$7.95

8080 SERIES

PART NO.	PRICE
BFINS8080A	$5.50
BFINS8085A	$19.95
BFDP8212N	$2.95
BFDP8214N	$5.25
BFDP8216N	$2.95
BFDP8224N	$3.25
BFDP8224-4N	$9.95
BFDP8226N	$3.50
BFDP8228N	$5.55
BFDP8238N	$5.55
BFINS8250N	$15.95
BFINS8251N	$7.50
BFINS8253N	$17.95
BFINS8255N	$6.80
BFINS8257N	$16.45
BFINS8259N	$18.00
BFINS8275N	$59.95
BFINS8279N	$24.95

FLOPPY DISC CONTROLLER

BFFD1771B-01	$24.95
BFFD1791B-01	$44.95

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Terms, U.S. VISA, MC, BAC, Check, Money Order, U.S. Funds Only. CA residents add 6% Sales TAx. MINIMUM PREPAID ORDER $15.00. Include MINIMUM SHIPPING & HANDLING of $3.00 for the first 3 lbs., plus 25¢ for each additional pound. Orders over 50 lbs. sent freight collect. Just in case, please include your phone number. Prices subject to change without notice. We will do our best to maintain prices through June, 1982. Credit Card orders will be charged appropriate freight. If you haven't received your Spring '82 Engineering Selection Guide, send $1.00 for your copy today! Sale prices are for prepaid orders only.

Circle 372 on inquiry card.

Unclassified Ads

FOR SALE: Apple II with 16 K memory. Pixe-Verter. program tapes. and manuals. $1000. Also have five issues of Creative Computing magazine for 1977 (July-August issue missing). six issues 1978. 12 issues 1979. and 12 issues 1980. $2 each. Also have issues 9-12 of BYTE for 1979 and all 12 issues for 1980. $2 each. Dale Arndt. 2900 McCann Rd. Apt. 415. Longview. TX 75604. (214) 758-1479.

FOR SALE: Two MITS 8800B computers. 64 K. Two MITS disk drives. cassette I/O. serial I/O. parallel I/O. BASIC. FORTRAN. COBOL. Pascal. $3000. Steve Mastrianni. 2952 Main St.. Coventry. CT 06238. (203) 742-6727.

ATTENTION: Schools that own Apple IIs with a disk: Are you tired of not having enough money for equipment? I am full of ideas and methods on how to make money using your Apple. Send a SASE for free information. Greg Lindahl. 10 Arbutus Trail. Greenville. SC 29607.

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FOR SALE: E & L MMD-1 microprocessor trainer in excellent working condition. Based on 8080A chip. Bug books 5 and 6. $150. Jerry Fidel. 1365 West 7th St.. Brooklyn. NY 11024. (212) 331-0028.

SELL OR SWAP: DEC PDP-8/L with 4 K core and TTY interface. PCB-L paper-tape reader/punch with interface cards and cable. No software or manuals for either at the moment. will pass along if I get them. Datalog MC8800 ultra-high-speed printer (optical). horizontal synchronization needs adjustment. complete user/maintenance manual with schematics. I will consider offers of DEC equipment. accessories. software. or money. or any combination of these. Duane Berry. RR 1. Box 105. Kempner. TX 76539. (827) 547-5536.

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FOR SALE: OSI Challenger 1P with 16 K R/W memory. 610 expander board. single minifloppy-disk drive. and Sylvania 9-inch monitor. Complete set of manuals and miscellaneous articles. $850 or best offer. Randy Raymond. 102 Maple Grove Way. Columbia. MO 65201. (314) 874-1711

FOR SALE: Two single-board computers. Fairchild F8 with 1 K static RAM. four parallel I/O ports. one serial I/O port. 20 mA/TTY interface. Fair-bug in ROM with documentation. card edge connector. schematic. and programming manual $60. Also. 1802 Super ELF with 2 K static RAM. monitor program in PROM. fully assembled with manual. schematic. and 13 issues of the 1802 newsletter. $75. Both for $110. Gordon Burnham. POB 141928. Orlando. FL 32807.

WANTED: California Computer Systems S-100 boards. Need used disk-controller board (#2422). I/O (2718 or 2710). 64 K (2065). and Z80 (2810) in usable condition at a reasonable price. Also need a Shugart 800/801R disk drive Ed Schneider. 8025 Coates Hwy.. Manistee. MI 49660. (616) 723-7859

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We Interrupt This BOMB . . .

For the second month in a row, Steve Leibson has captured first place. And this time it's no tie—he has it all to himself. For "The Input/Output Primer, Part 2: Interrupts and Direct Memory Access," Steve will be awarded the $100 purse. Second place goes to Ed Umlor for his review, "Integral Data Systems' Prism Printer." Ed will receive $50. Despite threats of bodily harm (and worse), we're forced to award third place to Steve Ciarcia for his article "Use Voiceprints to Analyze Speech." Well after all, Steve, you can't be first every month.

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