NOVEMBER 1981 Volume 6, Number 11
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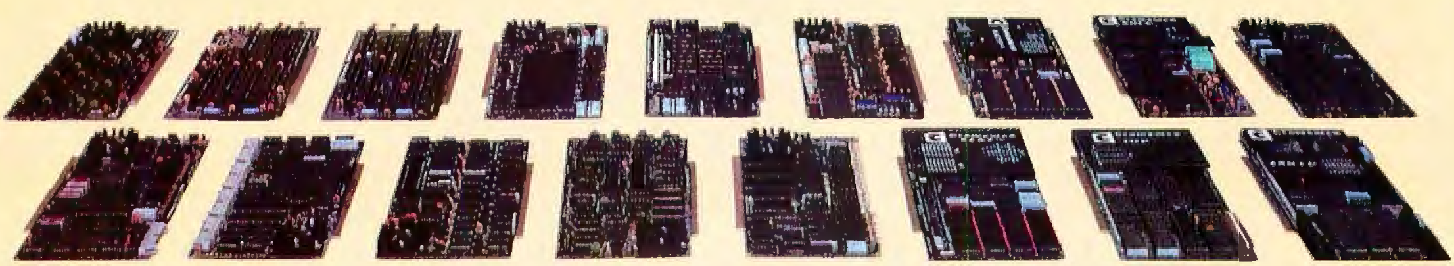
BYTE

the small sy... l

DATA BASE MANAGEMENT SYSTEMS

A new small computer that won't limit you tomorrow

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



Expandability

Circle 118 on inquiry card.

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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†CP/M is a trademark of Digital Research

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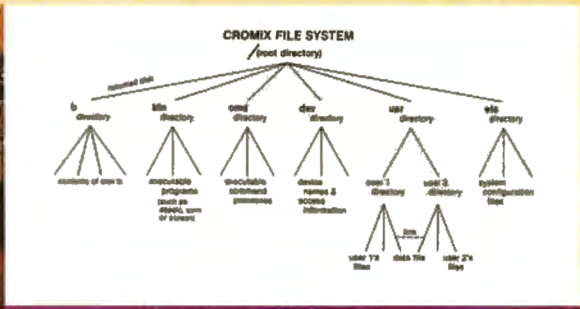

CROMIX*— Cromemco's outstanding UNIX†–like operating system

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

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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.

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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.

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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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In The Queue

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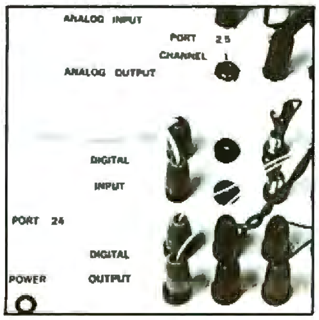

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In This Issue

Office workers who bravely face that ever-growing mountain of paper will tell you that keeping track of information becomes more difficult daily. How to impose order? As Robert Tinney's cover suggests, the answer is something like an electronic file cabinet.

This month's theme concerns the problems of data management. Joel Neely and Steve Stewart will get you started with "Fundamentals of Relational Data Organization." From there you can move on to "Data-Base Management Systems: Powerful Newcomers to Microcomputers," "A Survey of Data-Base Management Systems for Microcomputers," and "PDQ: A Data Manager for Beginners." "DIF: A Format for Data Exchange between Applications Programs" presents a strong argument for standardization of data formats. Apple II file-management systems are reviewed. And you can learn how to write with your data-base management system. Is spelling a nightmare? If so, you'll be interested in Phil Lemmons' review of the five major CP/M spelling-correction programs. Of course, there's Ciarcia's Circuit Cellar, BYTELINES, and our other regular features, too.

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Editorial

Can We Agree on Standards?

by Chris Morgan, Editor in Chief

Recipe for a heated debate:

- *Put two or more personal computer users in a room.*
- *Ask them to agree on a hardware or software standard.*
- *Stand back.*

Somewhat cynical? Perhaps, but the mere mention of a proposed standard often raises a whole crop of hackles. I suspect there are several reasons for this attitude: computer scientists are notoriously individualistic (not to say curmudgeonly); we are often reactionary because of our inbred love of ritual (if you doubt this, ask any psychologist who has studied computer people); and, perhaps most important, many personal computer industry standards are lacking in many ways.

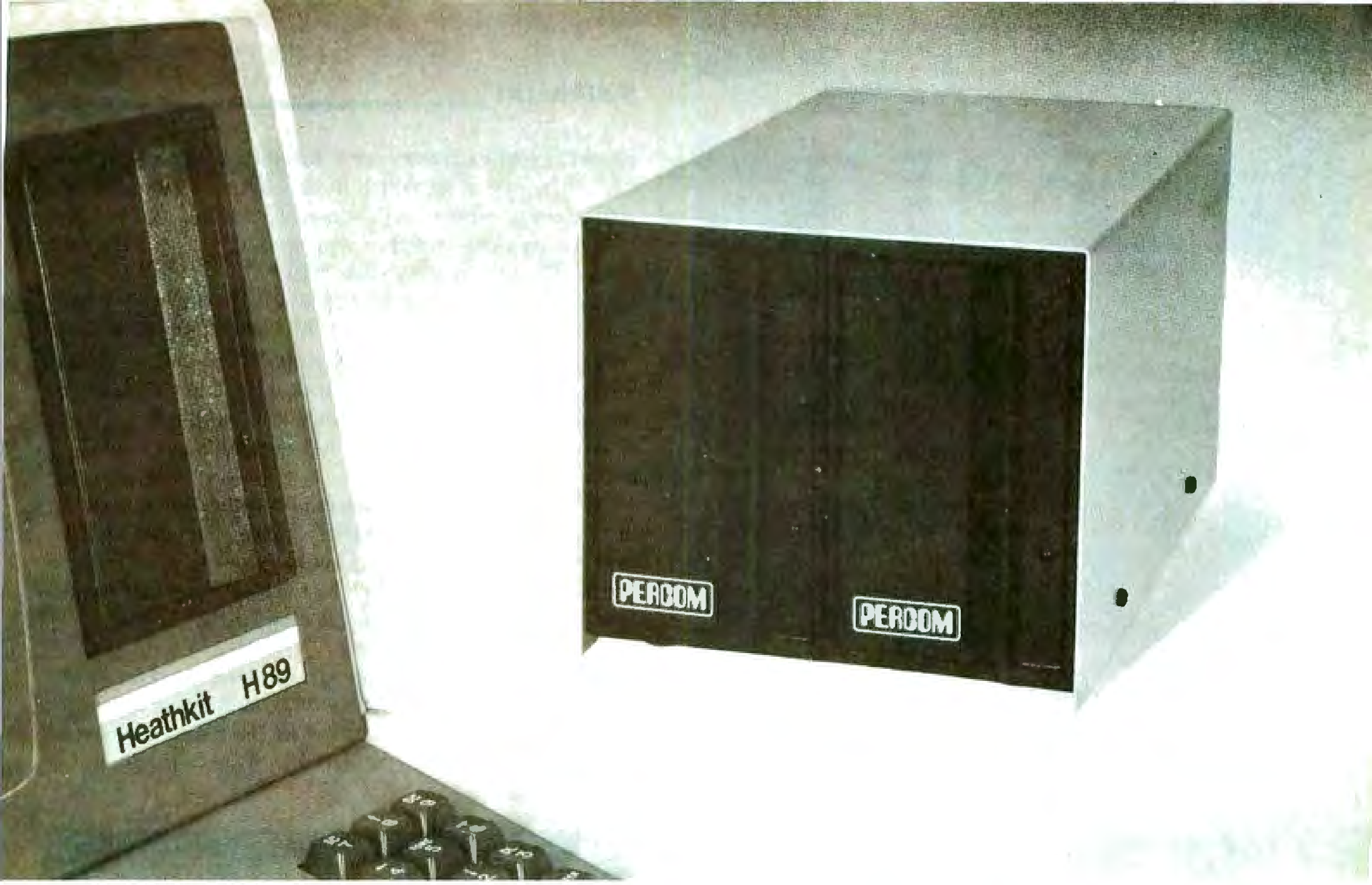
For example, we seem to have been poured into the BASIC mold, like it or not. (Although, ironically, BASIC is possibly the *least* standardized of the high-level languages.) One hundred ten baud is not exactly Mach 1. Standard television receivers leave much to be desired. The S-100 bus has only recently become a serious hardware standard, thanks mostly to the Institute of Electrical and Electronics Engineers (IEEE).

I remember the day when, fresh from seven years as an aerospace electronics engineer, I entered the BYTE offices and first saw an S-100 board. I was appalled at the number of connector pins—a design approach anathema to anyone whose circuits have to survive the vibrations of a moving aircraft. There simply was no excuse for putting 100 pins on a printed-circuit board when half that number would do.

Today I know that, far from being a disaster, the S-100 standard has proved its worth (although I *still* wouldn't want an S-100-based computer in the cockpit of a plane). So I guess I'm a bit of a curmudgeon myself. In fact, I've been known to take inordinate delight in approaching a group of good-natured hackers at a computer convention and innocently expressing my preference for BASIC over APL as "much the superior language," or the like. The resulting debate is often enough to activate nearby smoke detectors.

But returning to the question of standards, I want to bring to your attention a standard that just about everyone should like: it's called DIF (for Data Interchange Format). DIF was developed by Dan Bricklin and Bob Frankston at Software Arts (the developers of VisiCalc), aided by Mitch Kapor, inventor of VisiPlot. It's comprehensively described this month in an article called "DIF: A Format for Data Exchange between Applications Programs," by Candace E Kalish and Malinda F Mayer, on page 174. Briefly, DIF is a standard method for representing data in a program so that it can be transported directly to other programs, without time-consuming modifications. For example, a VisiCalc user might want to plot some calculated data using VisiPlot. (In fact, this is why DIF was initially developed.) Since both programs accept the DIF standard, the process becomes quick and straightforward.

As Bricklin explains it, "If you're building a box with pipes going in and out of it, it would be nice if there were one pipe that you knew other boxes could connect to. With DIF, we essentially define the diameter of that pipe and the



New! Z Controller and Z Drives . . .

Expect more from Percom. You won't be disappointed.

Percom's double-density Z Controller for the H-89 is now available.

Check its many outstanding features.

And keep in mind its from Percom, a company that introduced its first disk system in 1977.

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System requirements – H-89 Computer with 24 Kbytes memory (min), Replacement ROM Kit H-88-7 and HDOS 2.0.

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• Forty- and eighty-track densities in either 1- or 2-drive modules. • All drives are rated for single- and double-density operation. With a Z Controller, an 80-track drive can store over 364 Kbytes (formatted, one-side), a 40-track drive can store over 184 Kbytes. • Some models permit "flippy" storage, letting you flip a diskette and store files on the second side. • Z drives are fully tested, including a 48-hour operating burn-in to prevent shipment of drives with latent defects. • Assembled and tested one-drive units from only $399, two-drive units from only $795.

System requirements – H-89 or H-8 computer with 16-Kbyte RAM, Heath first-drive floppy disk system, HDOS and drives interconnecting cable. (Two-drive interconnecting cable optionally available from Percom)

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number of threads per inch." Another positive feature of DIF is the ease with which it can be used by novice programmers as well as experienced hackers.

Software Arts is actively promoting DIF through the nonprofit DIF Clearinghouse, POB 527, Cambridge MA 02139. Anyone adopting DIF will have his or her program added to the list of DIF-compatible programs, which can be obtained by writing to the clearinghouse. Several programs currently support the DIF standard (see the aforementioned article for a complete list). DIF appears to be a standard that has everything going for it, and I endorse it.

I'd like to hear from readers about the whole question of standards in our industry. Are our attempts to organize our lives futile? Should we even try? Is it inevitable that economics will be the lone arbiter of tomorrow's standards? I suspect this may be the case.■

We recently received word that Dan Bricklin is this year's winner of ACM's Grace Murray Hopper award for the most valuable contribution to the field by someone under age 30. Congratulations from all of us at BYTE...CM

Articles Policy

BYTE is continually seeking quality manuscripts written by individuals who are applying personal computer systems, designing such systems, or who have knowledge which will prove useful to our readers. For a more formal description of procedures and requirements, potential authors should send a large (9 by 12 inch, 30.5 by 22.8 cm), self-addressed envelope, with 28 cents US postage affixed, to BYTE Author's Guide, POB 372, Hancock NH 03449.

Articles which are accepted are purchased with a rate of up to $50 per magazine page, based on technical quality and suitability for BYTE's readership. Each month, the authors of the two leading articles in the reader poll (BYTE's Ongoing Monitor Box or "BOMB") are presented with bonus checks of $100 and $50. Unsolicited materials should be accompanied by full name and address, as well as return postage.

BYTE's Bits

Networking Scheme for the TRS-80 Model II

Tandy Corporation has arranged to use Datapoint Corporation's Attached Resource Computer (ARC) technology, software, and protocols for a high-speed TRS-80 Model II local network. Called ARCNET, the new network will let up to 255 Model IIs share peripherals and data bases. ARCNET can include Datapoint file processors, computers, printers, and 137-megabyte hard disks. For an ARCNET network, you will need a $400 board, which Tandy will sell and install, plus RG-62 coaxial cable and junction boxes to link the computers. One in four Model IIs on the network will function as a file processor.

Since Model IIs on the ARCNET network can share access to a large hard disk, there will be a version of the machine without a built-in floppy disk. Future Tandy computers will be ARCNET-compatible. Tandy will not adapt the TRS-80 Model III for the network, citing different screen parameters and operation speeds as the reason.■

Music Board Draws Criticism

Having read Rob Moore's article "Mountain Computer's MusicSystem" (see the July 1981 BYTE, page 60), I feel I must comment on some of the technical errors that give an incorrect impression of other synthesizers available for the Apple, particularly since our ALF synthesizers are mentioned several times in the article.

First, Mr Moore has an incorrect impression of the definition of "synthesizer." Contrary to his statements, all music cards available for the Apple that I'm aware of are truly synthesizers, not just Mountain Computer's. A "music synthesizer" is simply a device that creates music by "synthesis," i.e., by control of two or more parameters (each of which is only part of a sound) to produce a complete sound of the desired nature. Mr Moore seems to think that an ability to imitate conventional instruments is necessary in a synthesizer, but such is not the case. Actually, no synthesizer available for the Apple (and, for that matter, virtually no synthesizer of any sort) can imitate conventional instruments. Only Mountain Computer claims to be able to do this. A few moments of listening will convince anyone that the claim is advertising "hype": the unit simply cannot imitate most instruments well enough to fool even the moderately careful listener, much less someone very familiar with the instrument being imitated. Responsible companies make no such claim; the goal of synthesizers is to create music that sounds good and has sufficient variety, not to duplicate a conventional instrument's sounds exactly.

Mr Moore places the Mountain Computer synthesizer in the same class with Moog and ARP synthesizers, although they are almost totally different (the Mountain Computer unit, for example, uses additive synthesis and the Moog and ARP units are almost exclusively subtractive synthesis). Then he degrades the attack-decay-sustain-release method used on the ALF units, although this method is identical to the envelopes used on the expensive Moog and ARP. He specifically mentions that this method is difficult to use for piano-like envelopes, since they decay during sustain. This is incorrect. The fact that a piano decays during sustain simply means that the sustain level should be adjusted to zero and a very slow decay rate used. The abrupt drop upon key release is, of course, managed with a fast release rate setting.

In the realm of music notation, Mr Moore claims that music printed by the PRINT command can be cut and pasted to form an orchestral score. This, too, is incorrect. In an orchestral score (acutally "full score"), the measure bars will line up from part to part; the PRINT command does not adjust the music printout as it would be in a typical musical score. In fact, the PRINT command output is missing so many music features, notably beaming of notes shorter than quarter notes, that to an untrained eye it might not even resemble the original score, even if the various parts *are* pasted together.

Mr Moore also fails to understand the limits of the Apple's processor, except when discussing the particularly difficult case of software-driven D/A (digital-to-analog) synthesis. He mentions that three ALF 3-voice cards can be used for nine voices, which is true, but he states that an advantage of this card is that more voices can be added simply by using additional cards. If this were true, why not use four cards for twelve voices? In fact, the Apple processor is pressed to keep up with the nine voices. The processor-speed limitation affects every parameter controlled by the software. If the Apple were twice as fast, we would be able to have envelopes on the ALF card that were twice as smooth, which would result in a greater variety of sounds due to increased resolution and accurate control. The speed limit affects all synthesizers of all types, but the Mountain Computer system is particularly affected because the computer runs only at half speed during playback. Add the burden of 16 voices, compared to ALF's conservative nine, and you'll surely realize the Mountain Computer's software-controlled parameters (such as frequency and amplitude envelopes) must be very coarse indeed. In turn, this limits the variety of sounds available.

Mr Moore's statement that square-wave synthesizers have invariably sharp high notes and buzzy-sounding low notes is incorrect. Using Fourier analysis, which he describes on page 78, one can see that the harmonic contents of high and low notes are identical. The process he calls additive synthesis (used to create different sounds) can be done on every synthesizer available for the Apple, not just the Mountain Computer system. It is important to note that additive synthesis can be used only to *add* harmonics. Therefore, a square-wave synthesizer, already rich in harmonics, cannot produce low harmonic sounds using additive synthesis. By using very detailed and rapid envelopes on several channels, extremely complex and interesting sounds can be created. Because the Mountain Computer unit cannot produce very short notes (due to processor limitations I mentioned) and because it does not have a subroutine capability (which is essential, especially for echo/reverb effects), it cannot produce the types of sounds that are available on the square-wave units.

The greatest injustice done to the various competing cards lies in the text box "Music Making" on page 84 and in Moore's conclusions. He virtually declares that all other systems have advantages and disadvantages, but the Mountain Computer system has the best of everything. Each unit has its own best and worst factors. True, the Mountain Computer unit has a price of $545 and a full-blown ALF AMS system is $735 (not $795 as quoted in the article), but the ALF MC1 has as many voices as that full-blown system and costs only $195 (not to mention having all the goodies that on page 92 he wishes the Mountain Computer system had). As one might expect, these differently priced systems offer different types of performance. Despite Mr Moore's claims, the Mountain Computer system is definitely not the most powerful synthesizer available for the Apple II—no particular unit is.

Finally, it might be nice for readers to have our address and phone number. Rob Moore gives the phone number and address of every company he mentions except ALF. Our phone number is (303) 234-0871.

Philip J Tubb
ALF Products Inc
1448 Estes
Denver CO 80215

Rob Moore Replies:

I must concede Phil Tubb's point that any device that allows control of two or more musical parameters can accurately be called a synthesizer. According to his definition, however, the Apple's speaker, with its control of frequency and volume (on or off), is also a synthesizer. But I do not know of any "professional-quality"

A Busload from SSM.

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With 80 characters per line our VB3 is the perfect video interface for word processing. It produces a standard 80x24 display of upper and lower case characters or as much as 80x50 for a full page of text. The matrix for graphic display goes up to 160x200. And with optional EPROM, as many as 256 user programmed characters or symbols can be produced.

VB3 is memory mapped for rapid screen updating. But it occupies memory only when activated. So one or more VB3s can be located at the same address with a full 65K of memory still available to the user.

It generates both U.S. and European TV rates and meets IEEE 696.1 standard. Other features include keyboard input, black on white or white on black, one level of grey, underline, strike thru, blinking char., blank-out char., and programmable cursor. Software includes a CP/M compatible driver and a powerful terminal simulator.

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It operates at 2MHz or 4MHz by DIP switch selection and includes two sockets for 2716/2732 EPROMs or 2K RAMs. Memory sockets can be disabled. Separate run/stop and single step switches allow system evaluation without the benefit of a front panel.

CB2 also features an MWRITE signal, firmware vector jump, and an output port to control 8 extended address lines (allowing use of more than 65K of memory). Jumper options generate the new IEEE 696.1 signals.

8080 CPU

Our CB1A is identical to our popular CB1 with the exception that the on-board RAM has been increased from 256 bytes to a full 1K.

It also features an optional 2K of 2708 EPROMs, power-on/reset vector jump. MWRITE, parallel input port with status and DIP switch addressing.

Our S-100 line includes CPU, Video, I/O, 8 and 16 Bit RAM, EPROM, EPROM Programmer, Prototyping, Terminator, Extender, and Mother boards. Available assembled or as kits.

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Baked Apple.

Last Thanksgiving, a designer from Lynn/Ohio Corporation took one of the company's Apple Personal Computers home for the holidays.

While he was out eating turkey, it got baked.

His cat, perhaps miffed at being left alone, knocked over a lamp which started

synthesizer that does not offer some degree of waveform control, whether it is Moog, ARP, Synclavier, or even Radio Shack's new Moog unit.

In my article, I did not say that a synthesizer must be able to imitate real instruments. In fact, a synthesizer with control of a reasonable number of parameters will be able to produce recognizable instrument sounds as a by-product of its flexibility in sound production.

Mr Tubb has also apparently confused the meanings of the words imitate, simulate, *and* duplicate. *Neither I, nor Mountain Computer, claim that the MusicSystem can duplicate the sound of real instruments; however, it can produce recognizable simulations (or imitations) of a number of conventional instruments. This is an ability that is usually attractive to newcomers who have not had much experience with music synthesis, but who might enjoy simulating the sounds of familiar instruments.*

Mr Tubb is correct in his comments about the MusicSystem's PRINT command. Yet, that is why I referred to its output, when cut and pasted, as a ". . . sort-of-orchestral . . ." score. While unconventional, the result is still useful.

I'm afraid that it is Mr Tubb who fails to understand the capabilities of the Apple's 6502 microprocessor. If the 6502 is fast enough to generate D/A music, sampling four parts at 8 kHz each, then it certainly has the speed to sample 16 envelopes at several hundred samples per second. As a matter of fact, the MusicSystem's 8 ms envelope-sample period falls near the beginning of the 5 to 20 ms range of periods typically found in systems of this type. His comment that the envelopes must be very coarse in a 16-voice system (while smooth with the ALF's "conservative" nine voices) has no basis in fact. It sounds as though he is trying to say that "less is more"—that nine square-wave voices are somehow better at producing music than 16 variable waveform voices.

I stand by the statement that square-wave-only systems invariably have bright, sharp high notes and buzzy-sounding lows. Although both high- and low-frequency square waves have the same harmonic content, they do not have the same mix of frequencies. Additionally, the human ear's response drops off quite fast at low frequencies, so when a low-frequency square wave is played, the listener hears proportionally more of the high-frequency components—thus, the "buzzy" sound.

Regarding additive synthesis: Just as Fourier analysis decomposes a waveform into its simplest component parts (i.e., sine waves with frequencies that are integer multiples of the note's fundamental frequency), Fourier synthesis is used to construct a waveform from these same components. Although additive synthesis is often used as a synonym for Fourier synthesis, it may also consist of adding various arbitrary waveforms to synthesize the final result. But I cannot agree that a fixed-waveform music device can accomplish additive synthesis. Certainly some interesting and sometimes pleasant sounds can be produced, but rapid envelope variations are not the same as additive synthesis.

Mr Tubb is correct when he mentions, as I did in the article, that the Mountain Computer MusicSystem has no musical subroutine capability, while the ALF does. Fortunately, this is only a software limitation that will be corrected in the next software release and not a hardware limitation.

I do not believe that any injustice was done in the "Music Making" textbox in the article. When products of any sort are produced to meet specific cost goals, various trade-offs have to be made to stay within those limits. Inevitably, the trade-offs vary and different products will have their own strengths and weaknesses. Also, as electronic technology advances, prices will come down and allow features to be included that might have been too expensive a few years ago.

Mr Tubb also manages to confuse the terms most powerful *and* best. *The MusicSystem is the most powerful synthesizer currently available for the Apple II. It offers more voices and control of more musical parameters than any of the others. It is also relatively expensive and a bit more difficult to use than some of the lower-cost units. This is not to say that it is always the best choice for a given individual. The best choice is the unit that fits within the user's budget and offers the most acceptable combination of features.*

I'm sure that many people will find the ALF MC1 to be a good choice. With its nine voices and the excellent ALF software, the MC1 is a very good value.

DUE TO A PRINTING ERROR, the PerCom Heath Zenith ad on page 15 of the October issue should have been the PerCom ad for the TRS-80 drive systems. We apologize for any inconvenience this may have caused our readers.

Disk Storage: It's No Place to Compromise.

A dependable disk system means everything to the high-performance operation of your computer. At Percom, we know this. And we do something about it.

For example, the connectors on our TFD drive systems are gold plated.

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If the buyer can afford $545 or so, he or she should consider the MusicSystem. While its software could be improved in some areas, the MusicSystem's capabilities cannot be duplicated at this time.

An experimenter who wants to learn computer music from the inside out could take advantage of the excellent and inexpensive D/A music products offered by Micro-Technology Unlimited if he or she is willing to do some of the software work.

There are also a number of other inexpensive music cards—I have not tried them all. In short, there is no single system best for everyone. I suggest that readers go to a store and try out as many as possible and let their ears and budget decide.

I apologize for the inadvertent omission of ALF's address.

Mountain Computer Responds:

While the overall tone of Mr Philip Tubb's letter is extremely patronizing toward his own product and critical toward ours, I must say that Rob Moore's fine rebuttal covers many of the complaints that we would have in that particular category. There are one or two technical points that I will elaborate on here.

Our use of envelope control is one that represents a true envelope and how it actually occurs in an instrument, rather than in a conventionally synthesized method. This allows for the proper length and decay factors giving a more natural sound. Mr Tubb also fails to mention that his system cannot print any scores.

Another point that he brings out is that the computer runs at half speed on playback. While this is true, it is not a drawback because we can use the DMA capabilities of our system to our advantage. We service 16 voices without the information for the waveforms because the board has integrated intelligence. It can produce enough information for itself and the 16 voices simultaneously without the need for the Apple's 6502 processor's time. The ALF board, on the other hand, must be tied to the 6502 processor, continually using it to service the 9 voices and the envelopes. In short, we have very fine resolution on our waveforms and envelope controls, and ALF only has the envelope at a very low resolution point.

Additionally, the 9 voices (and that's only with three boards) are still not equal to or as versatile—that is the word Mr Moore used—as the Mountain Computer system. Without any argument on any other manufacturer's part, you will find the most capable and versatile system to be the Mountain Computer system.

Kent C Greenough, Director of Sales
Mountain Computer Inc
300 El Pueblo Rd
Scotts Valley CA 95066

A Little Ada Clarification

Having read "BYTELines" in the August 1981 BYTE (page 224) and having received several phone calls as a result of the article "Ada and Little Ada Released," I am prompted to write and clarify what may be a bit of a confusion.

TeleSoftware is wholly owned by a company called *TeleSoft*. TeleSoft does indeed have the first commercially available Ada compiler. It's called TeleSoft-Ada.

The juxtaposition of TeleSoftware's implementation of Ada and some information about "Little Ada" was unfortunate. There is absolutely no connection between TeleSoft-Ada and Little Ada.

Perhaps the confusion has arisen because only one address was printed at the end of the article, not ours!

Peter Dine, President
TeleSoft
10639 Roselle St
San Diego CA 92121

Setting the Record Straight

In the August BYTE, our MultI/OS for 8080 and Z80 systems was mentioned in "BYTELines." BYTE incorrectly stated that "like the others, it also maintains CP/M compatibility." We are not similar to the others, they are similar to us! InfoSoft has been the trailblazer in CP/M compatibility since we created the game with CDOS. Everyone else is trying to catch up to us. MultI/OS is a new product based on our single-user I/OS that has been around for more than four years. We have maintained CP/M compatibility for just as long.

Richard Roth, Vice President
Software Development
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Writing with a Data-Base Management System

Edward E Brent Jr, PhD
The Idea Works Inc
506 South Garth
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Nearly every microcomputer user appreciates the benefits of writing with a word-processing program. Pencil, paper, and typewriter can't match keyboard, video display, and line printer for speedy writing, editing, and printing of almost any kind of copy.

But word processing works best at relatively late stages in the writing process—after you've recorded your research results, compiled references, and constructed an outline for the project. In this article I show how another type of program, the data-base management system, can help you in the earlier stages of your writing. In fact, such a system can be *more* powerful than a word-processing program when you must perform a major reorganization of your text.

I first identify the stages of the writing process where a data-base management system (DBMS) can be most useful. Then I discuss the capabilities of such systems, detail their benefits, and recommend strategies for using the DBMS to maximum advantage.

About the Author
Edward Brent is assistant professor of sociology and family and community medicine at the University of Missouri in Columbia. He is also president of The Idea Works Inc, a research and consulting firm specializing in computer applications in research and design.

Although everyone has a favorite writing strategy, the process of writing can be broken down into several basic steps. After selecting a topic, the writer takes notes on ideas he may want to include. Next he outlines the article by organizing ideas and selecting a manner of presentation. The outline serves as a guide for composing the text, which is then revised until it satisfies the writer.

Limitations of Word Processing

When it comes to composing text, correcting it, and printing it out in an acceptable form, word-processing programs provide obvious advantages. But such programs lend themselves less well to note taking, outlining, and making major revisions. For these tasks, a DBMS can save time and energy.

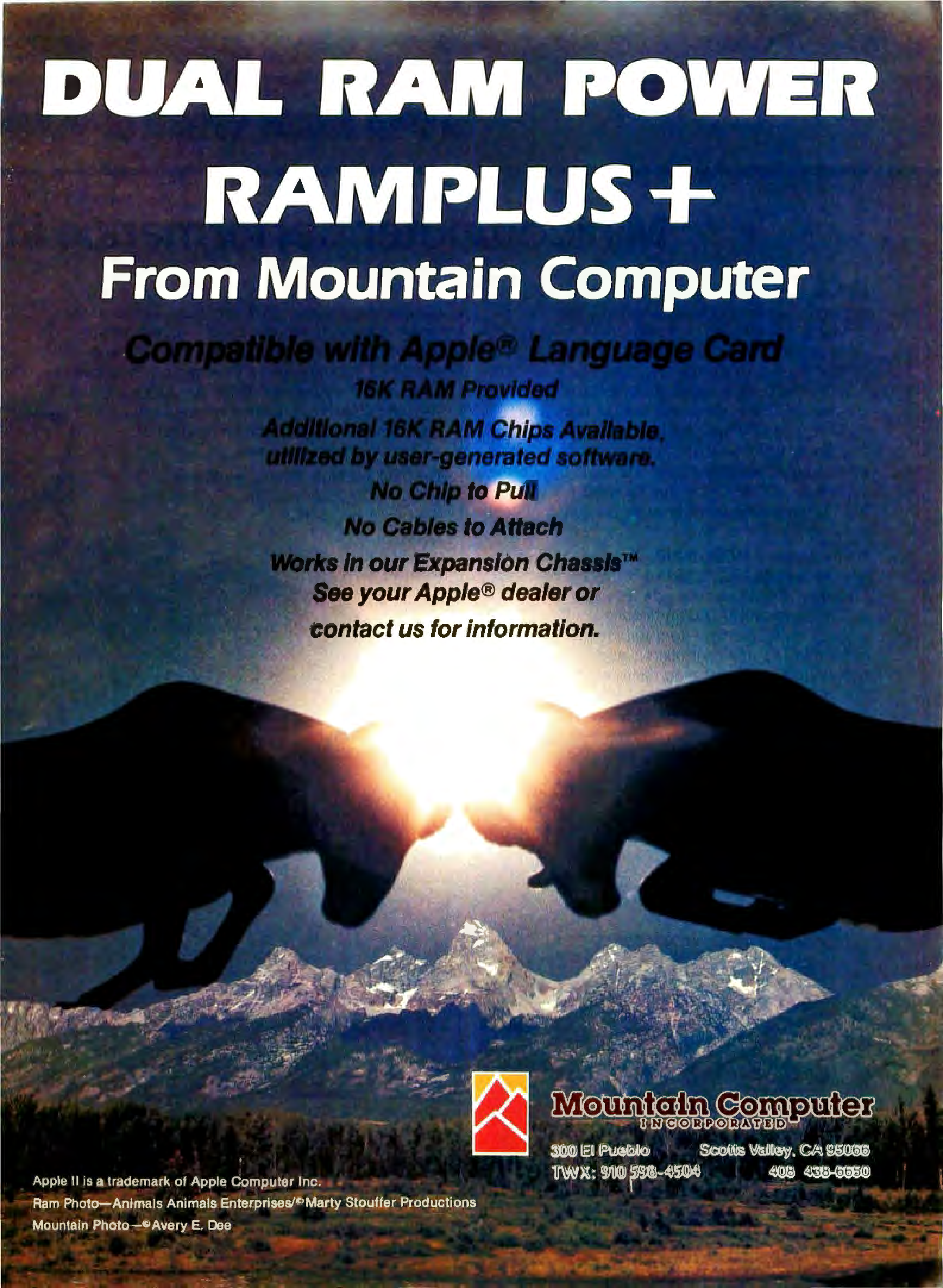
When taking notes, you need a mechanism for recording ideas so that they will be easily accessible later. Note taking also calls for a system to minimize effort without distracting you from the task at hand. Both note taking and outlining involve only small amounts of text—text that's rough and tentative at best. Word-processing programs don't deal well with text in this form.

At the revision stage, word-processing programs do an efficient job with minor changes. But if you must add many new ideas, delete many old ones, or drastically change the logic of your presentation, you may be better off with a DBMS.

DBMS Characteristics

To understand how a computerized data-base system can help you write, you must first understand its characteristics. A generalized DBMS is a set of related programs that allows you to enter a wide variety of data into a computer *file*, organize it for storage, then retrieve, update, reorganize, and print it out in the form of a summary report. Each file, a collection of related data, can contain almost any type of information you desire, so long as it meets the minimal structural requirements of the DBMS.

File Structure. Before entering any data into a file, you must first define the file structure. Files consist of a number of *records*, each containing similar information and referred to by a unique number or keyword. In writing, each record might contain a note on a particular idea, or a point made in another book or article to be cited in the paper. A record is a collection of *fields*, each having a name, length and position. Within each field are data describing each aspect of a record. Field names such as "title"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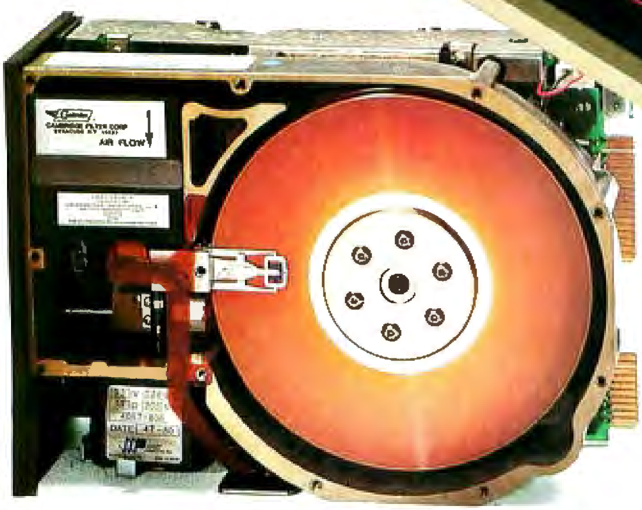

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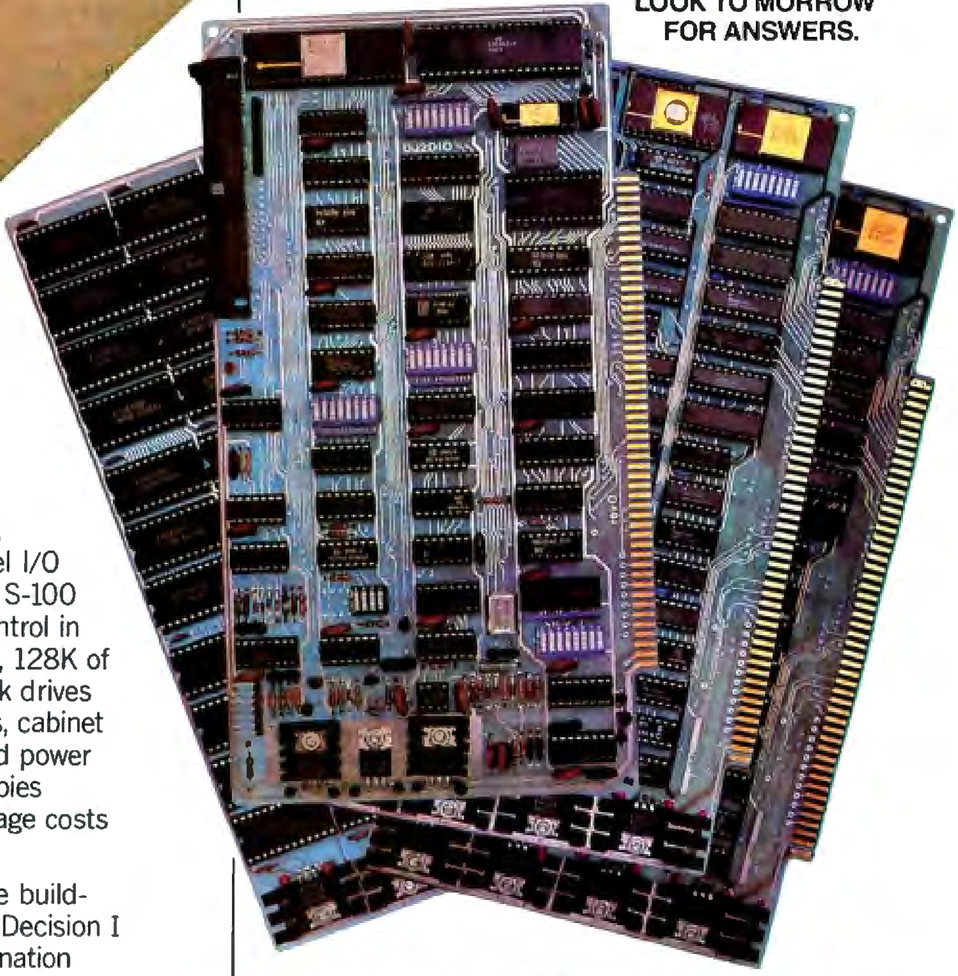

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and "author" identify the type of information stored in each field. The DBMS uses the length and position of the field to retrieve specific information.

Capabilities. Typical data-base management programs can perform a number of operations, including defining or creating a file; adding, modifying or deleting records; sorting the file according to some specific field; searching the file for records with certain values; and generating reports. You can store the data base created by these programs on a disk for future reference, and you can update it as your work on the paper progresses. Most data-entry programs prompt the user for relevant information and check to see that input data meet specified criteria. Others have sophisticated "query" languages that can perform arithmetic or Boolean algebraic manipulations on data in various fields. After computing percentages, totals, or other summary data, the program can store the data in another field or print it out. In essence, the DBMS is an electronic filing cabinet, storing information in various records and accessing and retrieving that information on command. Any particular record can be cross-indexed on many different key variables at the same time, and retrieved based on the value of those keys.

In microcomputers, a common method of sorting and retrieval used by the DBMS is the indexed sequential-access method (ISAM). This method uses a sequential access file to store the records as they are entered. An index is then created for that file, ordered by the values in the key field. The index is a table containing the key and the machine address of the record associated with each key. Records in the file may then be used according to their keys. The ISAM method provides the advantage of fast retrieval time.

Figures 1a, 1b, and 1c present a typical data base in terms of file structure, report format, and sample data records. These records are part of an extensive data base I used in writing this paper. In the TEXT field, each record contains a topic covered in this paper. A number of additional fields are used to take advantage of the capabilities of the DBMS to sort, search, and retrieve information. The characteristics of this data set are not particularly unusual, and you could use a similar strategy with many data-base management programs now available for microcomputers. The following sections discuss the advantages of the DBMS at each stage of writing.

Note Taking

If you can type, a DBMS can provide a fast and convenient means of recording notes. These may include quotes, summary notes referring to other sources, or your own ideas. A DBMS can be especially helpful when you spend a long time taking notes and then wait a while before actually drafting the paper. It is important to have some mechanism for recording ideas or references as they occur and then retrieving them later, when the

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paper is being outlined or written.

In many ways, note taking with a DBMS resembles note taking with note cards. For the note cards to be most useful, Lester (see references at end of article) suggests you put only one item of information on each card and include a brief citation or reference to the source of the idea. He also suggests you label the note card at the top for speedy recognition of the topic. When you record only one idea on each card, you can later sort the cards according to your outline for the paper.

All the functions performed by note cards can be carried out more efficiently by a DBMS. For each idea or quotation, you can create a record in the data-base file which includes as its main text the quotation or a statement of the idea. Key fields can be identified for reference to the author, journal, page, and date. To help you organize the ideas later, you can use other key fields to include a brief phrase that summarizes the context of the record. Several additional key fields could contain other types of information to sort the files in many different ways.

Because the DBMS can perform the tedious tasks of creating the indices and sorting the records, it requires far less effort on your part than note cards do. Once note taking becomes less burdensome, you can devote more effort to the task of developing new ideas.

Data-base management programs typically require you to define a structure before entering the data or notes. The programs then use that structure to prompt you for specific types of information as the notes are entered. When the information is complex, this prompting and structure can help you by assuring that you don't inadvertently leave out critical information (the author of a reference book, for example).

In addition to the structural constraints on data entry, data-base management programs typically include procedures which check the data for proper form during input. If you mistakenly enter alphabetic data in a numeric field, for example, the data may be rejected, and you will be asked to start again. In addition, more sophisticated programs allow you to specify other criteria which may be examined before the data are accepted—helping to assure the quality of the data entered and improving the quality of the notes.

Outlining

While data-base management programs save time and improve quality at the note-taking stage, these benefits pale in comparison to the benefits for outlining. Much writing, particularly for research papers or technical papers, involves keeping track of a mass of information on various topics. Managing all this information quickly and efficiently is an awesome job for even the most gifted writer.

For example, in writing a paper reviewing several different software programs or comparing various hardware options, you need to keep track of many details to provide a clear picture of what is available. Writing such papers requires a vast amount of relatively simple but time-consuming work such as compiling lists, sorting references and ideas, and reorganizing points to fit a consistent argument or theme (to say nothing of the many data-handling tasks involved in generating the notes in the first place). The computer can do all these things without overlooking important ideas or misplacing relevant citations, and it can work faster than the most efficient writer.

But the savings in time and effort aren't the only advantages to using a DBMS for writing. By allowing you to organize and reorganize your notes with minimal effort, the system frees you to consider many different approaches to your subject. This luxury can lead to valuable insights and significant improvements in the paper.

Revising

The sorting, retrieving, and updating capabilities that make the DBMS so useful for outlining also make the system valuable when your work needs major revisions. You can delete entire sections, add others, or reorganize your paper to fit a new

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Scott Kim is a doctoral student in Computer Science at Stanford University and is a concert pianist and composer.

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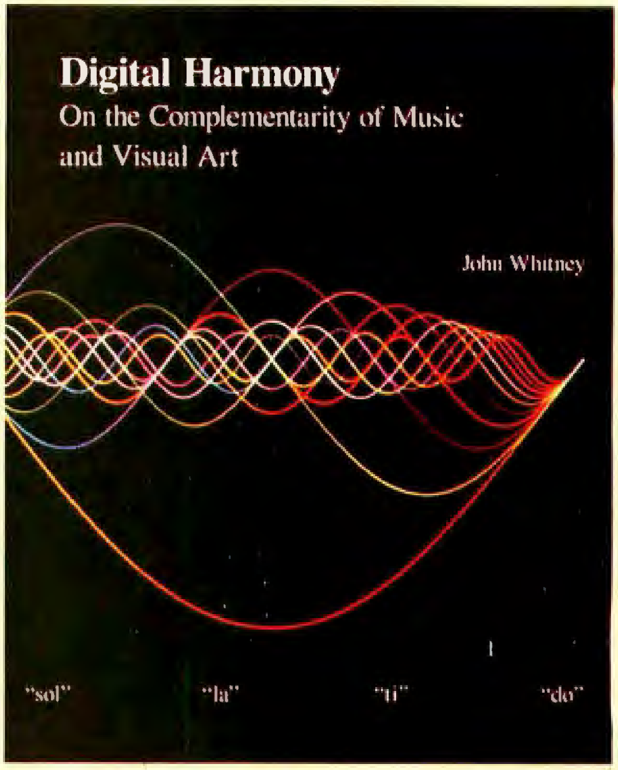

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John Whitney is on the Faculty of the Department of Art at the University of California, Los Angeles.

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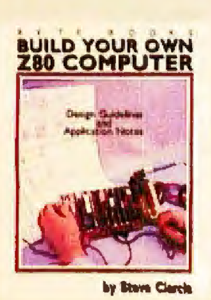

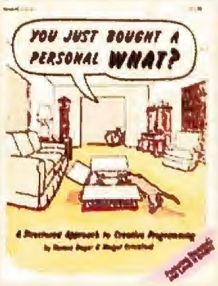

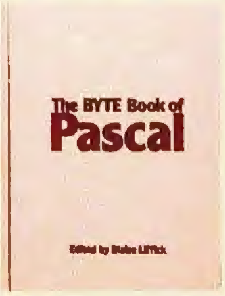

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Field Name	Length
HIERARCHY	25
ORDER	3
SUMMARY	8
KEY1	8
KEY2	8
TEXT	180

Figure 1a: *In a data-base management system used for writing, the data-base file consists of records, which in turn consist of fixed-length fields.*

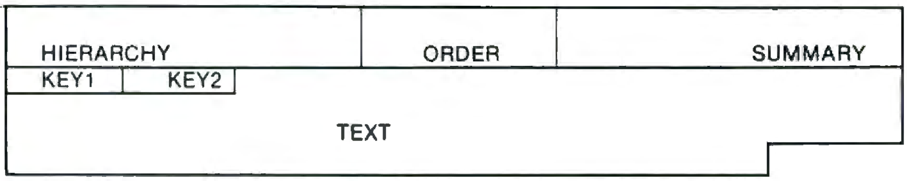

Figure 1b: *The report format used for printing out the records in the data base. The records in figure 1c follow this format.*

```
STRAT.STRUCT.CHANGE              S06      CHANGE
STRUCTURE        NOTES          IDEALLY, IT SHOULD B
E POSSIBLE TO CHANGE THE STRUCTURE AFTER
 THE IDEAS HAVE CHANGED SUFFICIENTLY THA
T IT IS NECESSARY TO MAKE IT RETAIN ITS
USEFULNESS.

STRAT.PROC.VOCAB                 S07      VOCAB
PROCESS          OUTLINE        TO TAKE MAXIMUM ADVA
NTAGE OF SORTING, SEARCHING, AND RETRIEV
AL CAPABILITIES OF DBM PROGRAMS IT IS NE
CESSARY TO CONTROL WORDS USED TO AVOID S
YNONYMS.

STRAT.PROC.THESAU                S08      THESAUR
PROCESS          OUTLINE        WHERE SYNONYMS MUST
BE USED, A THESAURUS MAY BE USED TO HELP
CONNECT THE APPROPRIATE WORDS.

STRAT.PROC.HIER                  S09      HIERARC
PROCESS          OUTLINE        HIERARCHICAL DATA ST
RUCTURES MAY BE INCORPORATED INTO THE KE
Y FIELDS THROUGH SUCCESSIVE SMALL FIELDS
OR A SINGLE LARGE ONE.

STRAT.PROC.INVERT                S10      INVERTED
PROCESS          OUTLINE        THE USE OF INVERTED
INDICES SUCH AS IN THE ISAM PROCESS IS L
IMITED AND ONLY WORKS WELL FOR SMALL FIE
LDS WHERE ALPHABETIC OR NUMERICAL ORDER
MAKES SENSE.

STRAT.PROC.SEQ                   S11      ORDER
PROCESS          OUTLINE        STRATEGY: ONE OR MO
RE KEYS MAY BE SET ASIDE TO BE USED TO O
RDER THE RECORDS LATER BY INSERTING KEY
VALUES APPROPRIATE TO SOME ORDER.

STRAT.PROC.UPDATE                S12      UPDATE
PROCESS          OUTLINE        REGARDLESS OF HOW WE
LL THE STRUCTURE IS DEFINED, IT WILL PRO
BABLY BE NECESSARY AND DESIRABLE TO UPDA
TE THE FILE AND CHANGE THE APPROPRIATE K
EYS AS IDEAS BECOME CLEARER.
```

Figure 1c: *Sample records (part of the data base used in writing this article) are shown printed out in report format. A word-processing program would be needed to provide lowercase output and line endings on word boundaries.*

theme or address new issues. Word-processing programs, however, may be a better choice for making minor revisions because they can conveniently modify and print out the text in the desired format.

Strategies for Using a DBMS

The standard advice on using a tool properly is especially *à propos* when the tool is a DBMS. Unless you start with a clear plan and a good knowledge of the tool's capabilities, a data-base-management system could actually impede your work. I'll present guidelines for the two major uses of a DBMS in writing: note taking and organization.

Note-Taking Strategies. At the note-taking stage, you must first set up a structure that takes maximum advantage of the DBMS's recording, structuring, prompting, data quality checking, and updating capabilities. At the same time, the resulting data base should be designed so that you can later use the system's organizing and retrieval functions. The watchword for note taking, then, is structure. Ideally, the structure should be appropriate to the task, inclusive, and flexible.

Appropriate level of structure. You can use data fields in several ways to provide structure consistent with your thinking. The first way involves *keyword fields*. Because ideas for a paper usually develop over time, you may not always know in advance the categories that will be relevant to the final paper. For this reason, you can make some provision in the data base for storing information in a flexible form such as open keys based on keywords, rather than rigidly prescribed categories fixed in advance. The second strategy uses *labeled fields*. If you can identify categories that will be relevant for the final paper, you can set aside specific fields for information relating to those categories. These keys usually have a restricted number of acceptable responses, which you may or may not know when you first define the field. You can develop new categories of acceptable responses for the field as the paper progresses. When you know in advance the categories and variables which define the fields, you can use abbreviated symbols called *table lookup keys* to represent the acceptable responses. You can then look up the symbols in a table if your computer cannot perform that function itself.

The sample data base in figure 1 (page 28) includes: two open key fields (KEY1 and KEY2) in which any key words may be entered; labeled fields (HIERARCHY, SUMMARY, and TEXT) in which only prescribed data may be entered; and one table lookup key (ORDER) in which only abbreviated symbols having specified meanings can be entered.

Inclusive structure. A data-base structure is of only limited use if it is not inclusive. A data base full of quotations, for example, does not help a writer unless it includes the information necessary for citing the appropriate references. During note taking, be sure to include all the information you'll need at the end; otherwise, you'll have to go back to the original sources to retrieve that information.

Flexible structure. Once you have created a data file, its structure (the number and size of data fields and the definition of permissible data for each field) is very difficult to change. You must, therefore, define the fields broadly enough to encompass likely changes in the categories without requiring major changes in the data structure. The sample data base in figure 1 contains several fields (HIERARCHY and ORDER in particular) that could not be filled out when the data were first entered, but they were very helpful later. No matter how well you plan the data structure, however, there may be times when your ideas change so much as the paper develops that the original structure no longer suffices. A few DBM systems allow you to change the structure later, but most do not. If yours falls into the latter category, you'll have to write a program if you want to change the structure. The program could convert existing data bases into new structures by deleting old key fields, adding new ones, changing the overall size of a record, or even converting values in existing fields.

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Organization Strategies. While organizing whatever you're writing, take advantage of the DBMS's ability to sort, search, and print reports. At the same time, you'll need to cope with the limitations of the DBMS. Some strategies for dealing with those limitations are discussed in the following paragraphs.

Thesaurus or vocabulary control. As you enter data into the various fields of the data base, you may encounter problems when you use more than one term for the same concept. For example, if you're writing about elderly people, a computer sort of the file may put all the "elderly" people in one place, the "aged" in another, and the "old" in still another. Computer-based data systems take expressions literally; they don't recognize synonyms. Because a file sort would not group together all the related records about elderly people, you would have to make a separate search for each possible term. One way to prevent synonyms from reducing the usefulness of the DBMS is to exercise control as the information is entered into the computer. You could also use a computerized thesaurus, which allows the computer to recognize different words that have similar meanings.

Hierarchical structures. Data fields may be used to create various types of data structures to meet your needs (see the Kerschberg reference at the end of this article). For example, many DBM programs are already set up to provide *relational* data models in which each record is classified by a common set of variables. *Hierarchical* data models store information in tree-like structures according to criteria which begin broadly and become successively more detailed. You can produce hierarchical data models with a typical DBMS in at least two ways. You can use one large key in which the hierarchical information is recorded in specified order (from most general class to most specific class) separated by delimiters such as slashes or periods. Another way is to use a series of smaller keys, each representing a specific level in the hierarchy. The first key might be the most general class; the second, the next most general, and so on. Either way, the key fields can be used in combination to order the records by some hierarchical scheme. This strategy is illustrated in figure 1 by the HIERARCHY field, which consists of a series of abbreviated terms separated by delimiters. The terms define the hierarchical relationship between the various records.

Use inverted indices sparingly. An inverted index is one in which records are ordered according to a sort done on one key field in each record. Using the indexed sequential-access method (ISAM), such indexes allow fast searching and record retrieval—much faster than you would get with an unordered data base. However, inverted indices have their limitations.

First, they order files alphabetically or numerically by the values in the *first portions* of keys. Hence, long keys such as titles are ordered only by the first few letters or words, which won't help you if the keywords of interest occur later in the title. In essence, inverted indices examine only the first segments of the text and do not consistently identify keywords imbedded within the text at other points. For fields containing several words, it may be best to use a search of the entire text in that field rather than an inverted index based on that field. One way to cope with this problem when using key words is to use several small key fields, each containing a single keyword, instead of using one long key field containing several keywords. This way, you can create separate inverted indices for each keyword without having to search the entire text. However, when the same term can appear in any of the key fields, the file must be searched several times, once for each of the possible fields in which the term may appear. This problem is illustrated in figure 1 by the TEXT field. There would be little point in creating an inverted index for that field because it would order the records by the first few words in the field.

A second limitation of inverted indices is that they order the file in alphabetical or numerical order, which may not be useful for the data

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at hand. To cope with this problem, you can make entries which, when ordered alphabetically or numerically, will meaningfully organize the data. For example, instead of labeling each strategy with a different summary label for sorting, you might start each with an identical label followed by a number. A DBMS will then place them together when sorting on that field.

When you can't use labels which naturally combine the appropriate elements in alphabetic or numeric order, try using special keys to record values that can take advantage of the sorting and retrieval capabilities of a DBMS. For example, you can make sure all comparable records end up together in a sorting analysis by using another key field to give each a distinctive letter and/or number.

This strategy is illustrated in figure 1 by the ORDER field. The "S" prefix causes the strategies to be sorted together and the following number determines the sequence in which the strategies will appear.

Update data as structures evolve. Although the structures of a data base are difficult to change, the data within those structures can be easily changed as errors are noted or ideas evolve. Be sure to take full advantage of this ability to modify the data as needed. In figure 1, for example, most of the records in the data base did not include information in the HIERARCHY or ORDER fields when I first entered them. The information was added later, as I developed a clearer picture of the paper.

In Summary

When you're undertaking a writing project, data-base management programs can be valuable supplements to word-processing programs. Together, the two programs allow you to use the computer to relieve much of the drudgery of note taking, indexing and typing draft after draft—thus freeing you to spend more time exploring new ideas. Data-base management programs are particularly useful for technical writing that involves complex arguments covering many issues.

The specific strategies I have discussed suggest some ways for putting data-base management systems to work for note taking, outlining and radically revising papers. You can experiment with strategies for handling still other tasks and making even more efficient use of the DBMS for writing. It would be particularly helpful to develop DBMS and word-processing programs that are compatible with each other. In that way, the data base created in the earlier stages by a DBMS could form the beginning of a text that would be modified and revised by the word-processing program.■

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1. Kerschberg, L, A Klug, and D Tsichritzis, "A Taxonomy of Data Models," in P C Lockemann and E J Neuhold (eds), *Systems for Large Data Bases*. New York: North-Holland, 1976.
2. Lester, J D, *Writing Research Papers: A Complete Guide*. Glenview, Ill.: Scott, Foresman, 1971.

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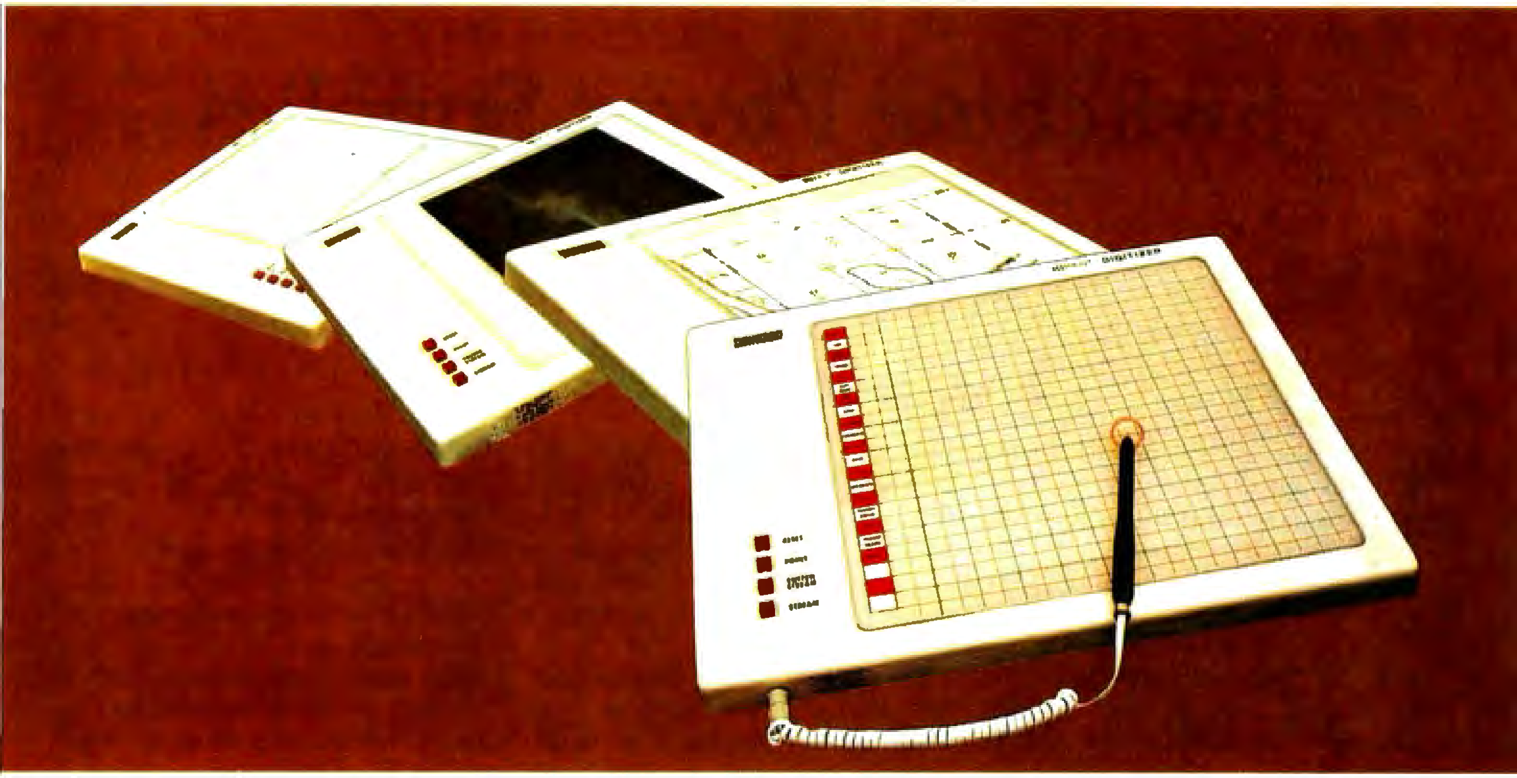

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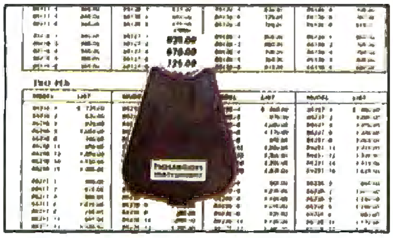

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Switching Power Supplies

An Introduction

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Since the advent of the three-terminal integrated-circuit voltage regulator, it seems that everyone has become a power-supply expert. No longer are ten pages of calculations required to produce a design for even a modest power supply, thanks to the wide tolerances and relatively sturdy architecture of these devices. After you have purchased a few readily available parts, you can have your completed supply running in a few hours.

Three-terminal regulators have become so easy to use that few experimenters stop to consider how inefficient they are. For example, if we were to design a 5-volt 1.5-amp power supply from commonly available parts, we would probably use a 12.6 VAC transformer, a bridge rectifier, a filter capacitor, a three-terminal regulator (such as an LM317), and a few discrete components. (A 6.3 VAC transformer is only marginally usable.)

Photo 1: *Ferrite toroids and pot cores are available in various sizes and compositions. These units are from the Ferroxcube Division of Amperex Electronics Corporation, 5083 Kings Hwy, Saugerties NY 12477, (914) 246-2811.*

Set up normally, the transformer, rectifier, and filter produce about 16 volts. With the LM317's output adjusted for 5 volts, 11 volts would be dropped across the regulator. ("Dropped" really means "consumed" in this case.) Power is dissipated by the regulator in an amount equivalent to the difference between the regulator's input and output voltages multiplied by the current through it. In this instance,

$$(16V - 5V) \times 1.5\ A = 16.5\ W$$

The conversion efficiency is

$$V_{OUT}/V_{IN} = 5/16 = 31\%$$

The LM317 and similar linear regulators (shown in figure 1) such as the 7805 and LM340 are all called *series dissipative regulators*. They function in a linear mode, simulating a variable resistance between the input-voltage source and the load. There are other factors involved, but basically the linear series regulator simulates a varying resistance. Within a specified range of variation in the input voltage and load current, the regulator maintains a constant output voltage by dissipating the excess power as heat. Unfortunately, as we see in this example, it consumes 16.5 watts producing the desired 7.5-watt output.

In most applications, however, the ease of use and relative low cost of linear series regulators far outweigh the inherent lack of efficiency. The linear series regulator is well suited for medium-current applications with a small voltage differential, where the power dissipation can be handled with heat sinks and cooling fans. When electricity costs only five cents per kilowatt-hour (1000 watts for one hour), it's hard to get concerned about losing 16.5 watts.

Why Use a Switching Regulator?

Power-supply efficiency usually isn't important unless size, heat dissipation, or total power consumption is limited. If the power source for our regulator were a battery, we would have to be more careful about how much energy is converted for useful work and how much is thrown away as heat.

Efficiency is really the name of the game. In a series dissipative regulator, conversion efficiency is directly related to the input/output voltage differential. As the difference between the two voltages increases, efficiency decreases. The power radiated by the regulator represents a loss to the system and limits the amount of power deliverable to the load.

It would be far better if the regulator consumed no power and if all the power were channeled to the load. While perfect conversion efficiency is impossible, the inherent fault in using series dissipative regulators is the linear operating mode of the series-pass transistor.

If, however, the transistor is used as a *switch* (in saturated operation) rather than as a variable resistor (in linear mode), the series-pass transistor consumes very little power. (This is not a new discovery. Designers have always been aware of the technique, but it required some time to develop cheap, fast switching transistors and inexpensive, low-loss ferrite materials from which cost-effective switching supplies could be built.)

A regulator constructed to operate in this manner is called a *series switching regulator*. The same series-pass transistor switches between cutoff and saturation at a high frequency, producing a pulse-width-modulated square wave of amplitude V_{IN}. This waveform is then filtered through a low-pass LC (inductance/capacitance) filter, producing an average DC output potential (V_{OUT}) proportional to the pulse width and frequency. The efficiency of such a regulator is generally independent of the voltage differential and can approach 95% in good designs.

Switching regulators come in various circuit configurations, a few of which are the flyback, feed-forward, and push-pull types. I am limiting this discussion primarily to another type, nonisolated single-ended (single-polarity) switching regulators, because they are the easiest to understand and build. Although simple, they are nonetheless quite useful. Unlike the typical three-terminal dissipative regulator, the switching regulator can be directly configured to operate in any of three modes: step-down, step-up, or polarity-inverting.

Switching-Regulator Basics

Figures 2a through 2c on page 39 outline the three common modes of switching-regulator operation.

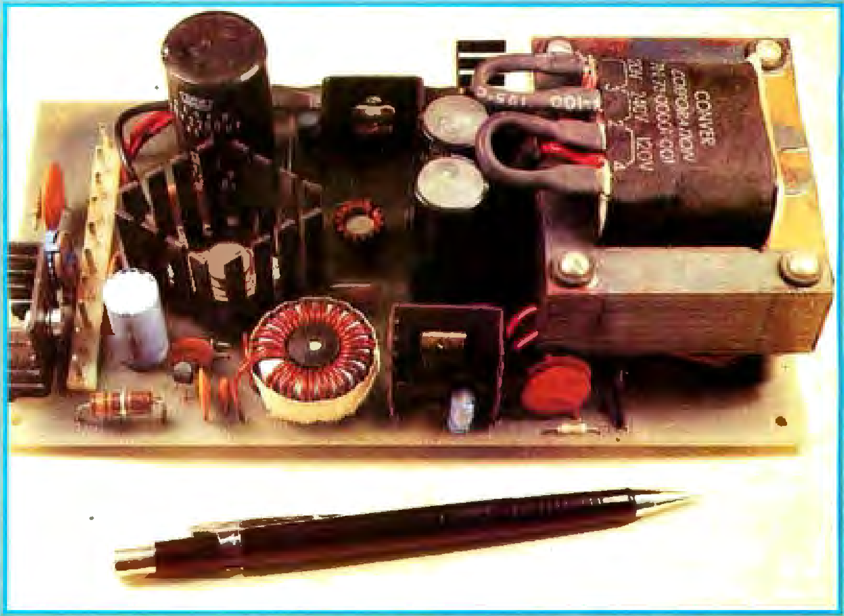


Photo 2: *A commercially sold switching power supply that combines both linear-regulator and switching-regulator technology to provide outputs of ±12 volts and +5 volts. Note the use of the toroidal inductor and the relatively small heat sinks. This unit was made by Conver Corporation, 10631 Bandley Dr, Cupertino CA 95014, (408) 255-0151.*

Basically, the switching regulator consists of a power source which supplies a voltage V_{IN}, a "switch" Q1, and an LC filter. (It is assumed in all cases that a load is connected between the output and ground and that Q1 is actually a transistor controlled through external circuitry.) The way the components are connected determines the output mode.

In the *step-down* regulator of figure 2a, the basic circuit operation is to close switch (transistor) Q1 for a time T_{ON}, and then open it for time T_{OFF}. The total, $T_{ON} + T_{OFF}$, is called the switching period T. Neglecting the saturation voltage of Q1 (V_{SAT}) and the diode (V_{DIODE}), the voltage at the input to the inductor is $+V_{IN}$ during the time T_{ON} and zero during T_{OFF}. (But remember, these other voltage drops must be included in our calculations when we are choosing actual components.)

When Q1 is closed, a step increase in voltage is applied to the inductor coil, which has the value L. However, current flowing through an inductor cannot change instantaneously; instead it increases linearly according to the factor $L(di/dt)$, building a magnetic field. This reduces any instantaneous current change seen by the load. When Q1 opens, the magnetic field in the inductor decays linearly, supplying power to the load. The current path is completed through the forward-biased flyback diode D1.

In this type of switching regulator, the inductor and capacitor form a low-pass filter. High-frequency pulses are applied to the input, and an averaged DC level comes out. The peak-to-peak ripple voltage is a function of the switching period T and the values of the inductance L and capacitance C. As the frequency of operation is increased, the voltage ripple is reduced, but the supply becomes less efficient.

Figure 2b illustrates the circuit configuration of the basic *step-up* switching-type voltage regulator. In this type of regulator, closing Q1 during T_{ON} charges the inductor. When Q1 is opened, the inductor discharges through D1 into the load. The output voltage is determined by the rate of discharge according to the equation

$$V = L(di/dt)$$

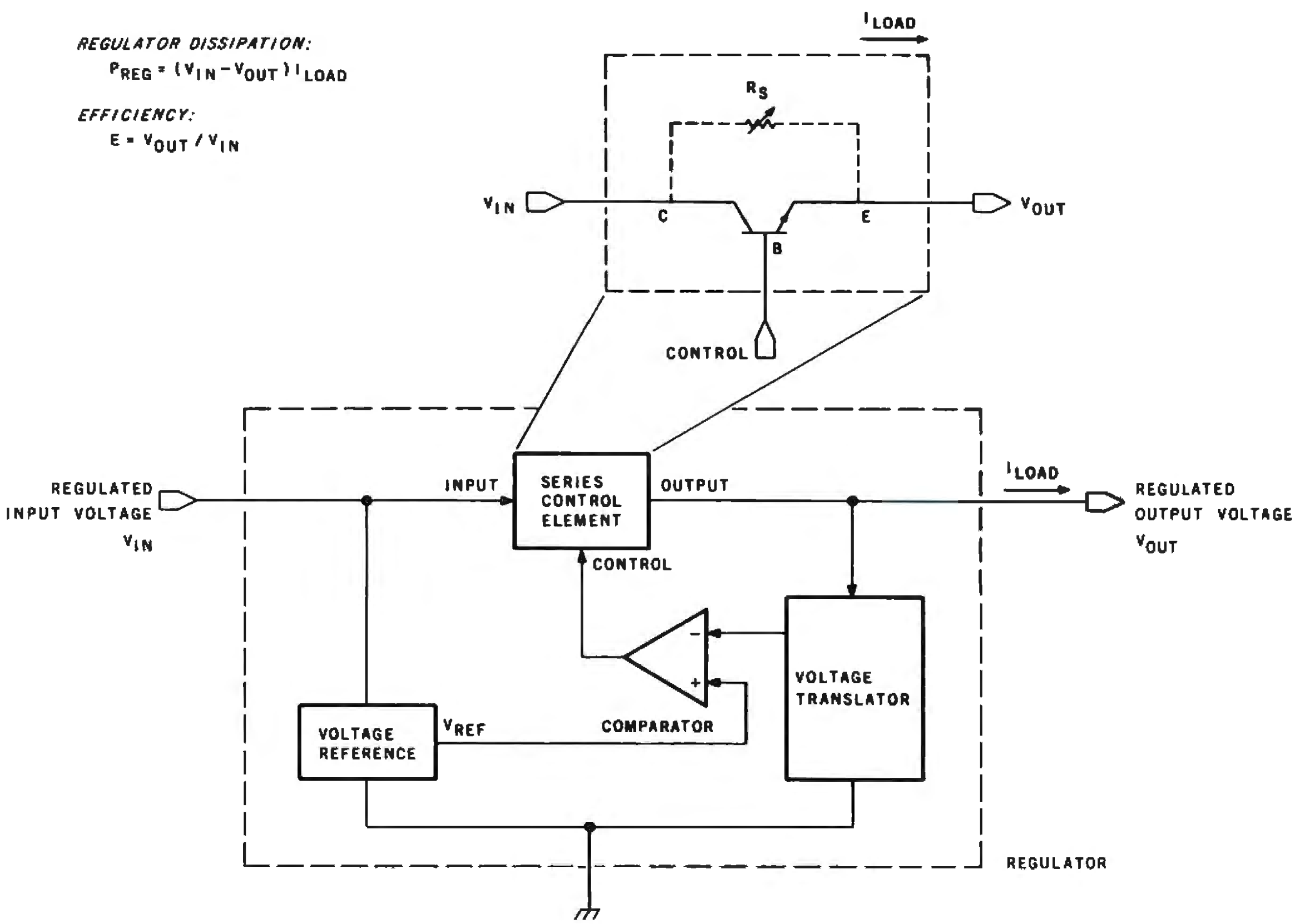


Figure 1: *Block diagram of a typical linear series voltage regulator, such as the LM317, LM340 or 7805. The series regulator acts as a varying resistance, dissipating excess power as heat to maintain a constant output voltage.*

A fast discharge delivers an output voltage higher than input V_{IN}.

Figure 2c shows a *polarity-inverting* switching regulator. As in the other cases, closing Q1 charges the inductor during T_{ON}. When Q1 is opened during T_{OFF}, there is a "kickback" voltage produced by the inductor as it discharges. This effect occurs elsewhere, too. For years, many of you have probably been putting reverse-biased diodes across relay coils, perhaps without thinking about it. The purpose of the diode is to dampen the high-voltage spike produced when a pulse is applied to the inductive relay coil. In the power-supply situation, rather than short out the voltage, diode D1 directs this opposite-polarity voltage to the load.

Generally speaking, in all three cases, the output voltage V_{OUT} is regulated by controlling the ratio of T_{ON}/T. This *duty cycle* can be altered in a number of ways depending upon the control method. Two of the more common approaches are variable pulse width (pulse-width modulation) and variable frequency. In a pulse-width-modulated switching regulator, the switching period T is fixed and the "on" time T_{ON} varied. Conversely, in a variable-frequency regulator, T_{ON} is fixed and the "off" time T_{OFF} varied.

You can experiment with a simple design for a nonisolated single-ended switching voltage regulator.

The variable-frequency switching regulator is generally easier to design and build, since the magnetic flux developed in the inductor coil during the fixed on-time determines the amount of power deliverable to the load. This eases the design of the inductor because the inductor's operating region within its characteristic curve is precisely defined. Operating frequency, which increases proportionally with the load, is primarily a function of the inductance L, capacitance C, and voltages V_{IN} and V_{OUT}.

The fixed-frequency pulse-width-modulated switching regulator varies the duty cycle to change the average power delivered to the load. This method is particularly advantageous for systems employing transformer-coupled output stages and is most

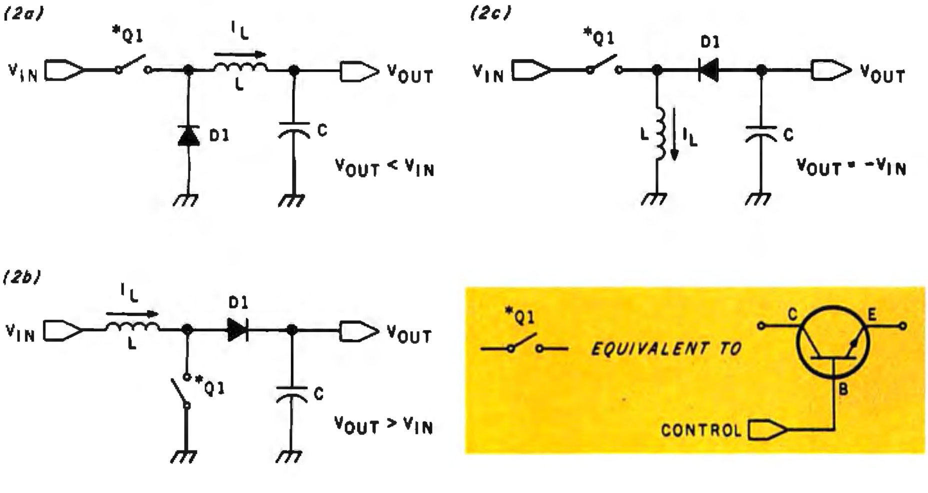


Figure 2: *The configurations of switching voltage regulators: the voltage-step-down (2a), voltage-step-up (2b), and polarity-inverting (2c) arrangements are depicted. The component shown as a switch is assumed to be a bipolar transistor driven in saturated switching mode. Some commercial designs may use field-effect transistors.*

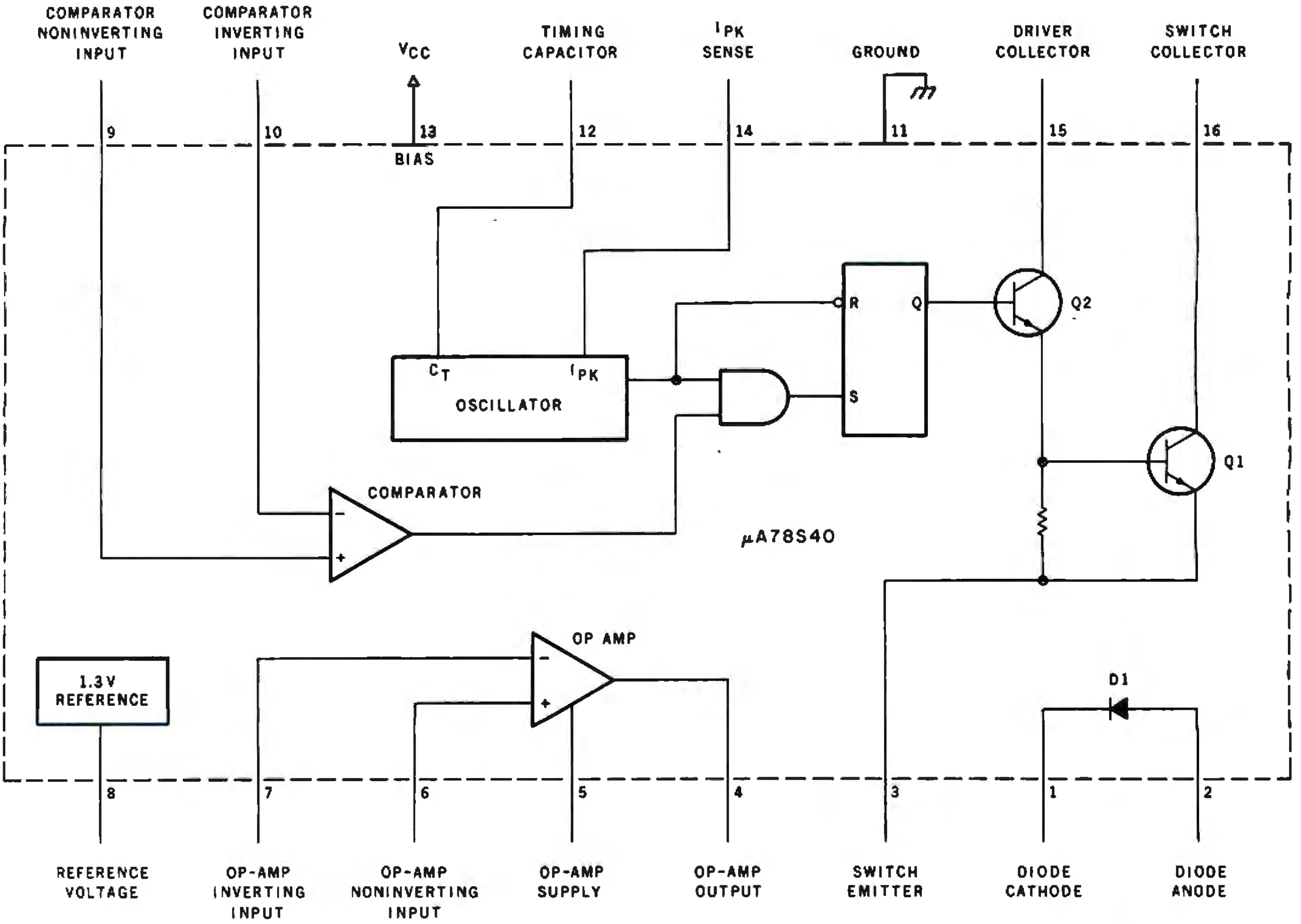


Figure 3: *Functional block diagram of the Fairchild 78S40 switching-regulator integrated circuit. This component may be obtained from the supplier listed on page 45.*

often used in commercial switching supplies with multiple outputs. This method is more complex and uses more components than variable-frequency supplies, but the advantages outweigh the extra cost in high-current applications.

Typical operating frequencies of switching regulators range from 10 to 50 kHz. However, there are some trade-offs. High frequencies reduce the ripple voltage at a price of decreased efficiency and increased radiated electrical noise. If the frequency is lowered, greater efficiency and less electrical noise will result, but larger coils and capacitors are needed. Also, a switching power supply operating at 10 kHz can become quite annoying to listen to after a while.

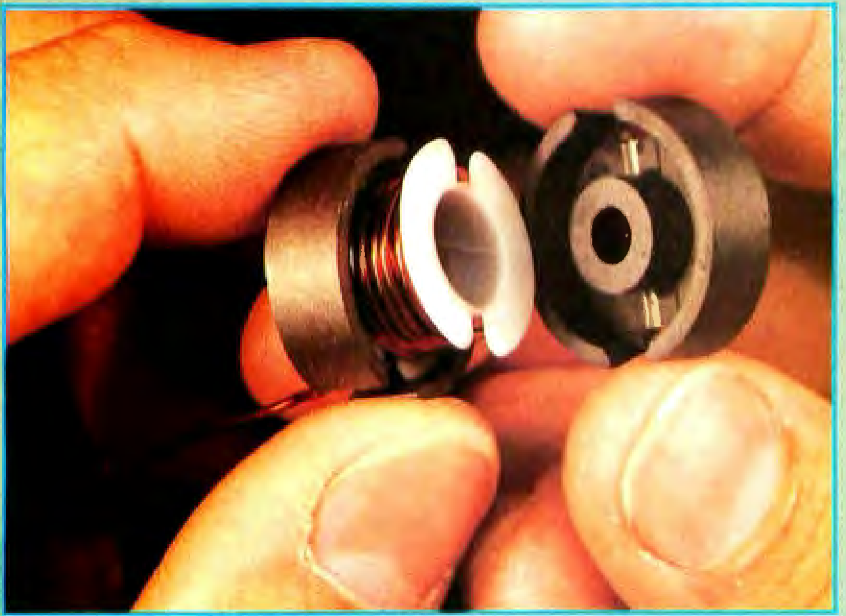


Photo 3: *Winding the inductor for the switching supply of figure 6a. The turns of wire are neatly wound around a plastic bobbin, evenly distributed.*

Photo 4: *Having been wound, the wire bobbin is placed between the two halves of the pot core, which are screwed together to form the finished coil.*

The most effective frequency range for optimizing efficiency and size with the components presently available is around 20 kHz. This is out of the range of human hearing yet low enough to be within the switching speeds of most inexpensive transistors and diodes. As switching speeds of newly developed high-current semiconductors increase and new ferrite components are introduced, practical operating frequencies will rise.

There are many kinds of switching regulator circuits that I could present. My previous article, "No Power for Your Interfaces? Build a 5 W DC to DC Converter" (reference 3), discussed the construction of a 5-watt converter which produced ±12 volts from a +5-volt input. This circuit was intended to facilitate powering linear interfaces and op amps (operational amplifiers) when the only source available was the 5-volt logic supply. If you have such a requirement, I refer you to that article.

This time, however, I'd like to present circuits to meet a different need. In the example of the conventional power supply with which I began this article, the input/output voltage differential was so great that more heat than useful energy was produced by the supply. In a small electronic package which requires several watts, dissipated heat can be difficult to remove if the enclosure has no vents. This points out a need for a more efficient 5-volt regulator. While we're at it, we might as well make one that can accommodate up to 30-volt inputs without significantly increased losses.

One power supply that seems to be in demand lately is one with a +25-volt output for programming EPROMs (erasable programmable read-only memories, as discussed in last month's Circuit Cellar; see reference 2). While a three-terminal regulator can be used for this voltage, I see this as a ripe opportunity to demonstrate the step-up variety of switching regulator. One circuit we'll look at will therefore be a +5-volt to +25-volt converter suitable for EPROM-programming use.

78S40 Switching Regulator

In recent years, monolithic (everything built on one semiconductor chip) linear voltage regulators have simplified power-supply design. Most systems have employed linear regulators because of their excellent reliability, low external parts count, and low cost. However, recent improvements in high-speed switching transistors and low-loss inductors have made switching supplies more attractive. The real breakthrough came with low-cost LSI (large-scale integration) monolithic switching regulators, which contain practically everything but the inductor on a single chip.

One of the many such integrated regulators available is the Fairchild 78S40, which is shown in the block diagram of figure 3. The 78S40 contains a current-controlled oscillator, current-limit sensor, voltage reference, high-gain comparator, high-current op amp, transistor switch, and power-switching diode. A single capacitor sets the frequency range (adjustable between 100 Hz and 100 kHz, but normally used at 20 to 30 kHz), and one external resistor provides current-limiting protection for the transistor and diode. Other than a few discrete resistors to set the output

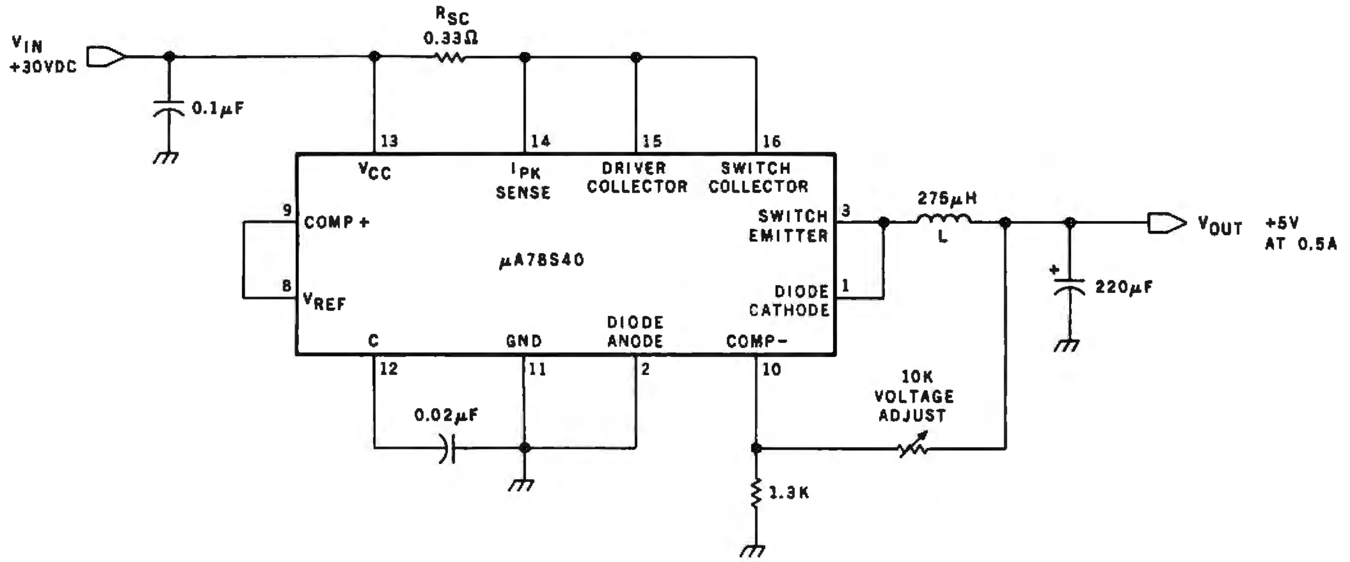


Figure 4: *Schematic diagram of a 5-volt, ½-amp step-down switching voltage regulator. For low currents, the 78S40's internal switching transistor and diode may be used.*

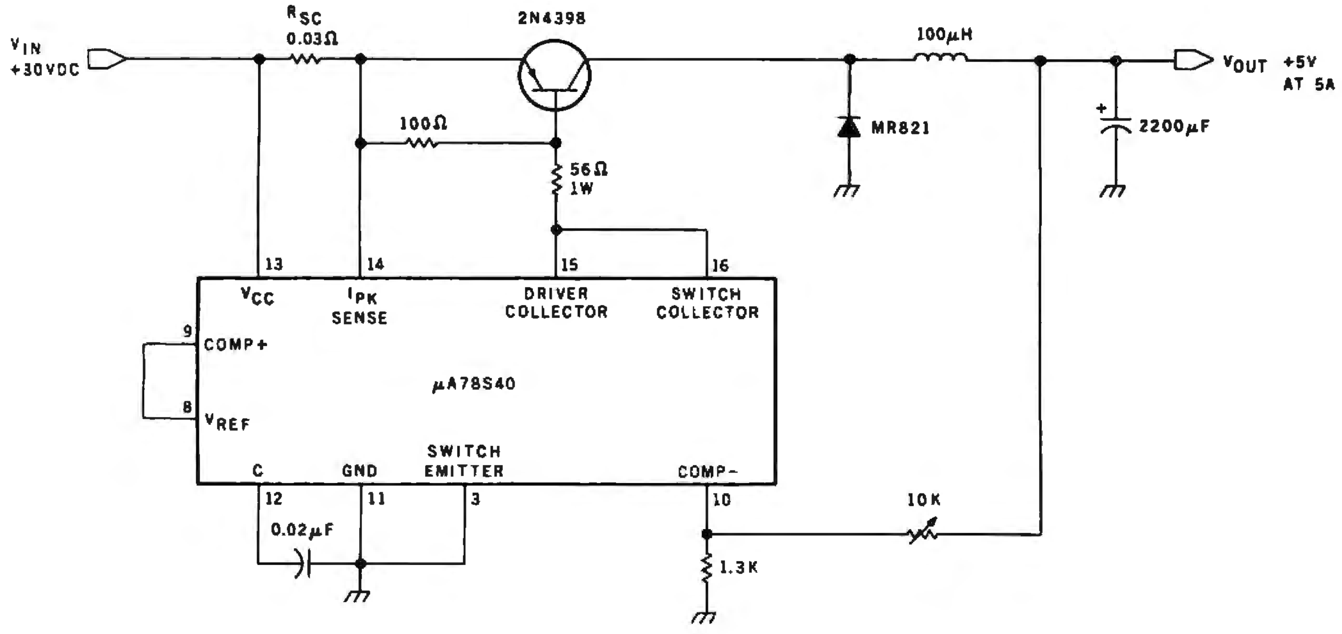


Figure 5: *Schematic diagram of a 5-volt, 5-amp step-down switching regulator. An external heat-sinked transistor and diode are needed for the higher current.*

voltage, only an inductor and capacitor are required to make a highly efficient switching power supply. The internal Darlington-configured transistor switch and diode are capable of handling up to 1.5 amps (peak) at 40 volts.

While virtually no calculation is required to design a circuit that uses a three-terminal linear regulator, you have to do some math to arrive at the correct values for the external components to use with switching regulators. A simple circuit to demonstrate the math is a standard step-down regulator, as shown in the schematic diagram of figure 4. This circuit is a 30-volt input, ½-amp, +5-volt regulator, with a computed efficiency of about 82%. The computation appears in the text box "Component-Value Calculation" on pages 44 and 45.

Photo 5: *Close-up of the pot-core halves and the bobbin.*

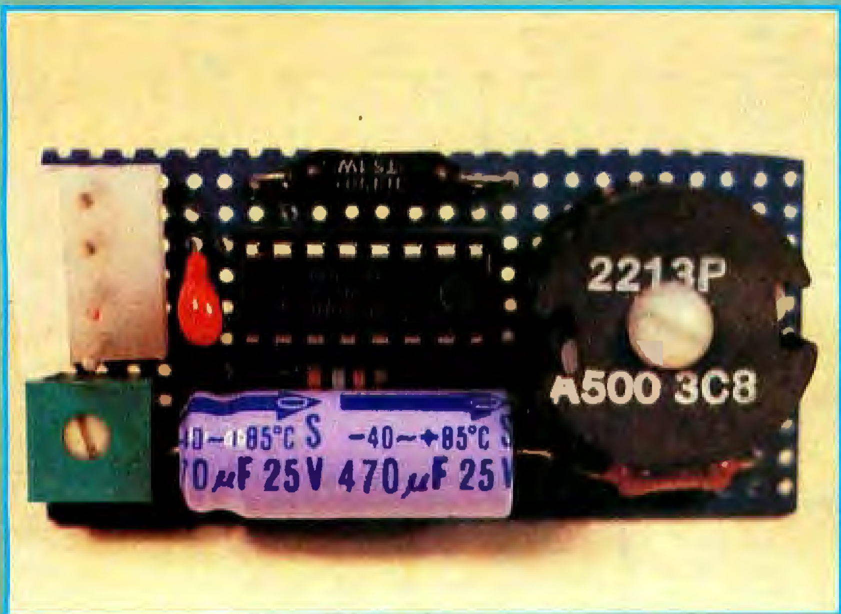


Photo 6: *A prototype of the step-up switching regulator of figure 6a. This circuit can be adjusted to produce voltages between +8 and +28 volts.*

In applications where the peak current is greater than 1 amp or where you need voltages greater than 40 volts, an external diode and transistor should be used with the 78S40. If you want to experiment, figure 5 shows a regulator designed to provide +5 volts at 5 amps. The component values were selected using the same equations described in the text box. After I had actually built the unit, however, I was unable to get a current greater than 3 amps out of it. I attributed this to using thinner wire in my inductor winding than I should have.

Another switching-power-supply circuit that might prove useful to you is shown in figure 6. Configured as a basic voltage-step-up regulator, this simple circuit converts +5 volts to +25 volts. With the voltage-adjustment pot shown, the circuit's output actually can be adjusted within a range of +8 to +28 volts. Set to +25 volts, it can be used as an EPROM-programmer supply. The design current rating is 200 milliamps, but this is dependent upon the output voltage. At 8 volts I measured 175 milliamps, but at 25 volts the maximum current was only 30 milliamps. Overall efficiency was about 70%. To achieve higher output currents at 25 volts, it is necessary to use an external switching transistor.

Winding the Inductor

The inductor coil in a switching regulator is designed for high power and large currents. Typically, the windings are around a ferrous core that is toroidal in shape, somewhat like a doughnut. The selection of a specific core size and core material for a desired inductance at a given steady current level is done through a set of iterative calculations using analytic curves showing permeability reduction versus DC magnetizing force (measured in oersteds).

The problem in selecting a core of suitable size and permeability is that all these parameters are interrelated. Rather than attempt to make everyone understand the curves and calculations, I prefer to take a little poetic license, by choosing a core which is optimal for the types of switching supplies I have just described. The remaining calculations are minor and less likely to discourage you from winding your own inductor.

The core I have chosen is the Ferroxcube 2213PA500-3C8, a pot-core set which differs from a pure toroid in that it consists of two cups which are secured together around a bobbin, around which, in turn, the windings are wound. Since the wire is wound on a bobbin rather than around the ferrite material itself, it is easy to change bobbins and experiment with various inductances produced by different numbers of turns and kinds of wire. Figure 7 outlines the characteristics of type-2213 pot core.

Two other factors are noteworthy in this selection. The type-2213 core is made in a variety of ferrite materials. I have chosen to use a type of material known as 3C8, which is a manganese-zinc ferrite substance with medium permeability and low losses. It is designed specifically for high-flux-density applications such as power supplies.

The 2213PA500-3C8 is a fixed-gap pot core. Flux saturation is avoided by introducing an air gap in series with the magnetic path. The effect of this 0.025-inch gap is to flatten the hysteresis loop, allowing greater cur-

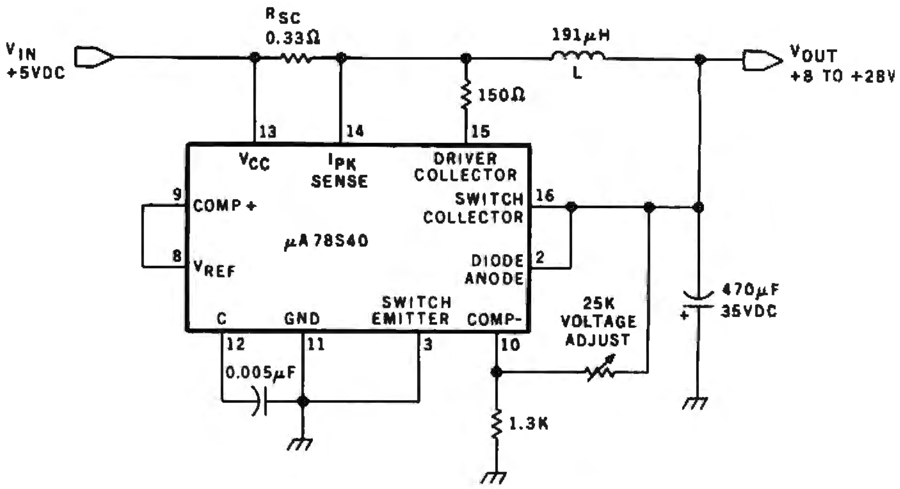


Figure 6a: *A step-up regulator that converts +5 volts to +25 volts, possibly for use in an EPROM programmer. The output voltage may be adjusted within the range of +8 to +28 volts. Current capacity depends on fine points of construction and on the voltage desired.*

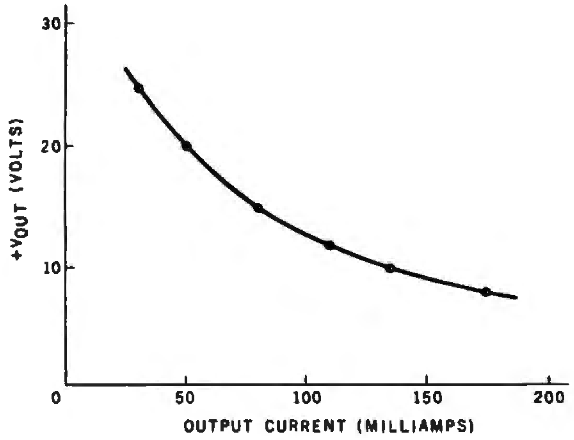
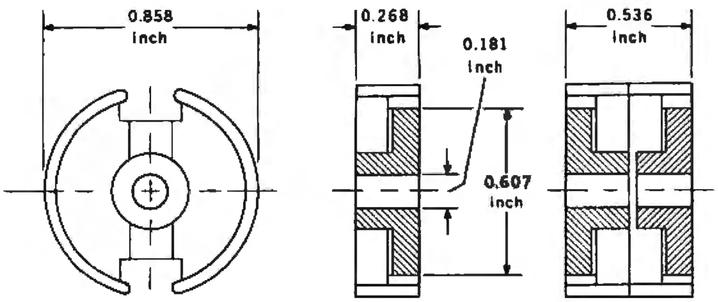


Figure 6b: *The measured curve of output voltage plotted against current for the step-up switching regulator of figure 6a.*



MAGNETIC PATH LENGTH	ℓ_e	1.23 inches 3.15 cm
CORE CONSTANT	$\Sigma \frac{\ell_e}{A_e}$	12.6/inch 4.97/cm
EFFECTIVE CORE AREA	A_e	0.0985 inch^2 0.635 cm^2
EFFECTIVE CORE VOLUME	V_e	0.122 inch^3 2.00 cm^3
MILLIHENRIES PER 1000 TURNS	A_L	500

Figure 7: *Physical and electromagnetic characteristics of the Ferroxcube 2213PA500-3C8 pot core. The coil turns are wound around a plastic bobbin that fits between the two core halves, easing experimentation with different numbers of turns and different gauges of wire.*

rent densities without saturation. An added plus is that it reduces the overall inductance per turn of wire and allows more turns of wire for a given inductance value. Pot cores work best when the windings completely fill the core.

The calculations for winding the specific inductors for the power supplies I have presented are relatively simple. For each core and material, the manufacturer specifies a proportionality factor A_L, which is the inductance in millihenries per 1000 turns. The inductance for any other number of turns N is then

$$L = A_L N^2 \times 10^{-9}$$

or

$$N = \sqrt{\frac{L \times 10^9}{A_L}}$$

where

N = number of turns
L = desired inductance in henries
A_L = millihenries/1000 turns

The 5-volt ½-amp regulator presented earlier required a 275-microhenry inductor. For the 2213PA500-3C8 core, $A_L = 500$ millihenries per 1000 turns. Plugging these values into the equation:

$$N = \sqrt{\frac{0.000275 \times 1000000000}{500}}$$

$$= \sqrt{550}$$

$$= 23 \text{ turns}$$

In addition to determining the required number of turns, we must con-

Component-Value Calculation

Conditions:

V_D (diode-saturation voltage) = 1.25 volts
V_{SAT} (transistor-saturation voltage) = 1.1 volts
V_{IN} = +30 volts
V_{OUT} = +5 volts
I_{OUT} (maximum) = 0.5 amps
$V_{RIPPLE} < 1\%$ = approximately 50 millivolts
V_{REF} = (internal reference voltage) = 1.3 volts

Calculate:

$I_{PEAK} = 2I_{OUT}$ (maximum)
$= 2 \times 0.5$
$= 1.0$ amps

The peak-current rating of the transistor is 1.5 amps.

Next, determine the value of the current-limiting resistor:

$R_{SC} = 0.33/I_{PEAK}$
$= 0.33/1$
$= 0.33$ ohms

Calculate the T_{ON}/T_{OFF} ratio:

$$T_{ON}/T_{OFF} = \frac{V_{OUT} + V_D}{V_{IN} - V_{SAT} - V_{OUT}}$$

$$= (5 + 1.25)/(30 - 1.1 - 5)$$

$$= 6.25/23.9 = \text{approximately } 0.26$$

Therefore:

$T_{ON} = 0.26\ T_{OFF}$

It is desirable to have the operating frequency of a switching regulator above 20 kHz (yielding a 50-microsecond period T), but neither T_{ON} nor T_{OFF} should be less than 10 microseconds for the 78S40 device. If we arbitrarily choose T_{OFF} to be 40 microseconds, then the values of the oscillator-timing capacitor (C_T) and inductor (L) are computed as follows:

sider the wire size and available space within the core. The objective is to fill the core, yet maintain a wire size that will carry the highest currents involved. There exist tables and charts of wire size, circular mils per ampere, and available-area specifications for exact determinations. As a rule of thumb, with designs like the ones presented here, the best tactic is to use the largest wire size that will fit for the required number of turns. If the pot core is not completely filled, the effect is not disastrous, but the true inductance could be as much as 10% less than calculated.

In Conclusion

I consider this subject a bit of a shot in the dark. I have found that as I build miniaturized electronic devices for my own use I can no longer tolerate the large volume, weight, and inefficiencies of linear-regulated power supplies. This article is a progress report on some of the circuits I have been experimenting with lately.

I don't anticipate any sudden shortage of ferrite cores as a result of the publication of this article. In my opinion, switching power supplies will come to have a very significant role, but mostly in commercially produced products. The greatest benefit of using this technology is the savings in energy and materials in large-scale production.

Next Month: *Have you ever wished you could call your computer by telephone and give it commands by pushing the buttons on a Touch Tone receiver? In December's Circuit Cellar we'll look at several schemes for decoding DTMF (dual-tone, multiple-frequency) signals.* ■

$$C_T = 0.00045\ T_{OFF}$$
$$= 0.00045 \times 0.000040$$
$$= 0.018\ \mu F$$

Using a 0.02-microfarad standard capacitor value, T_{ON} and T_{OFF} really turn out to be:

$$T_{ON} = 11.6\ \mu s$$
$$T_{OFF} = 44\ \mu s$$
$$T = T_{ON} + T_{OFF} = 55.6\ \mu s$$
$$C_T = 0.02\ \mu F$$

For the inductor:

$$L = \frac{(V_{OUT} + V_D)\ (T_{OFF})}{I_{PEAK}}$$
$$= (5 + 1.25) \times 0.000044/1$$
$$= 275\ \mu H$$

The output-capacitor value C is calculated from the ripple requirements:

$$C = \frac{(I_{PEAK})\ (T)}{8\ (V_{RIPPLE})}$$
$$= 1 \times 0.0000556/8 \times 0.05$$
$$= 139\ \mu F \text{ (use standard 220 } \mu F)$$

Finally, compute the values of the two resistors required for the sampling network. Assuming that the comparator-input current is 1 milliamp (the comparator will work down to 100 microamps) then:

$$R1 + R2 = 5 \text{ k-ohms}$$
$$R2 = (R1 + R2)\ (V_{REF}/V_{OUT})$$
$$= 5 \text{ k-ohms} \times 1.3/5$$
$$= 1.3 \text{ k-ohms}$$

Select $R2$ = 1.3 k-ohms and use a 10-k-ohm potentiometer for $R1$.

Parts Source

A switching-regulator kit is available to experimenters. The kit contains one Fairchild 78S40 integrated circuit, two 2213PA500-3C8 pot-core halves, and two plastic bobbins; it is available postpaid in the United States for $11.50. Only prepaid orders will be accepted. Send check or money order to:
The MicroMint, Inc
917 Midway
Woodmere NY 11598

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Editor's Note: *Steve often refers to previous Circuit Cellar articles as reference material for the articles he presents each month. These articles are available in reprint books from BYTE Books, 70 Main St, Peterborough NH 03458.* Ciarcia's Circuit Cellar *covers articles that appeared in BYTE from September 1977 through November 1978.* Ciarcia's Circuit Cellar, Volume II *presents articles from December 1978 through June 1980.*

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Fundamentals of Relational Data Organization

Joel Neely and Steve Stewart
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Both mathematicians and computer scientists use the word *elegant* to describe a concept of exceptional clarity, simplicity, and utility. By those standards, the relational model of data organization is most elegant. One of the principal advantages of this model is its foundation upon a formal mathematical theory that allows its concepts to be defined and examined with great precision.

This article discusses the basic concepts of the relational approach to data organization and looks informally at the practical benefits of the model. We should point out that our emphasis is on data organization, to the exclusion of other interesting and important issues in database system design, such as the syntax and features of the data-definition and data-manipulation languages.

The Sample Data Base

As an example of the capabilities of the relational model we will use a personnel data base, which is to be developed for the use of a data-processing manager. It should contain the following information: the name of each employee (EMP), the languages that the employee is familiar with (LNG), the number of years the employee has used each language (USE), the employee's position within the organization (POS), the employee's years of experience with the company (EXP), the employee's hourly pay rate (PAY), the current project to which the employee is assigned (PRJ), and the project manager on each of these projects (MGR).

PERSONNEL1 (see table 1) shows a small sample of data that might be stored in this data base and gives the structure of the data base. (In the structure diagram headings, parentheses enclose groups of data that may be repeated, while an underline indicates *key* columns whose values identify an entire entry.)

With the design of PERSONNEL1, any request of the form:

Tell me something about employee E

may be satisfied easily. However, it is much more difficult to respond to the following requests:

List the names of all employees who use language L
Tell me the manager of project P
Display the names of all employees assigned to project P
Change the manager of project P to employee E

Through a process known as *normalization*, the organization of the data may be revised to increase the flexibility with which it can be used. Before presenting the details of this process, we need to establish some terminology.

A *relation* is a two-dimensional table (as in PERSONNEL1) consisting of horizontal rows and vertical columns. The advantage of this form is that almost everyone is familiar with data presented as a simple table. No two rows in the relation may be identical; there must be some combination of columns—a key—whose values will uniquely identify each row. In our example, we gave each employee a unique name, so EMP may be used as a key in

About the Authors
Joel Neely, an adjunct associate professor in the Mathematical Sciences department at Memphis State University, is president of Janus Systems, a custom software firm.
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PERSONNEL1. In practice, there may be more than one way to construct a key to a relation. Social-security number and time-clock number are values that might also be used to identify an individual employee.

Normalizing the Data

The first step in normalizing our personnel-data design is based on the following rule:

RULE 1: *For all rows, each column must take a "simple" value, ie: a single value without repetition.*

In PERSONNEL1, the columns labeled (LNG, USE) and (PRJ, MGR) are in violation of this rule, because an employee may know more than one programming language and may be assigned to more than one project. By duplicating the nonrepeating values EMP, POS, EXP, and PAY for each combination of values for the repeating groups (LNG, USE) and (PRJ, MGR), the entire relation may be represented in first normal form, as shown in PERSONNEL2 (see table 2).

Notice that in PERSONNEL2, the column EMP is no longer sufficient to identify a row. Multiple rows may be present for an employee who has more than one entry for language use or project assignment. One possible solution is to consider the combination of EMP, LNG, and PRJ as a key, since those three values together are sufficient to identify a single row.

It would appear at first that PERSONNEL2 represents a step backward, not only because it requires much more space than PERSONNEL1, but also because responding to the requests

Change employee E's position to S
Add the assignment of employee E to project P
Make employee E the manager of project P

has become much more difficult. This problem is addressed by the remaining normalization steps, which are based on the concept of *dependence*.

PERSONNEL1:

EMP	(LNG, USE)	POS	EXP	PAY	(PRJ, MGR)
Bogard	COBOL,3 FORTRAN,2	Sr Prog	4	25.00	Payroll,Smith A/R,Jonas
Dalton	COBOL,2 PL/I,1 RPG,3	Sr Prog	3	24.00	Inventory,Fitch
Fitch	COBOL,4	Prj Mgr	2	32.50	Inventory,Fitch
James	COBOL,5 GPSS,2	Sys Anl	2	29.00	A/R,Jonas Datacomm, Spivey
Jonas	AMBIT,1 BLISS,2 COBOL,1 Pascal,3	Prj Mgr	1	31.00	A/R,Jonas

Table 1: *PERSONNEL1, a sample of a personnel data base set up as a nonnormalized table.*

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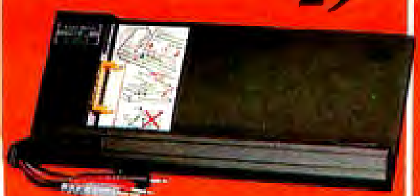

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PERSONNEL2:

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Bogard	COBOL	3	Sr Prog	4	25.00	A/R	Jonas
Bogard	FORTRAN	2	Sr Prog	4	25.00	Payroll	Smith
Bogard	FORTRAN	2	Sr Prog	4	25.00	A/R	Jonas
Dalton	COBOL	2	Sr Prog	3	24.00	Inventory	Fitch
Dalton	PL/I	1	Sr Prog	3	24.00	Inventory	Fitch
Dalton	RPG	3	Sr Prog	3	24.00	Inventory	Fitch
Fitch	COBOL	4	Prj Mgr	2	32.50	Inventory	Fitch
James	COBOL	5	Sys Anl	2	29.00	A/R	Jonas
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James	GPSS	2	Sys Anl	2	29.00	Datacomm	Spivey
Jonas	AMBIT	1	Prj Mgr	1	31.00	A/R	Jonas
Jonas	BLISS	2	Prj Mgr	1	31.00	A/R	Jonas
Jonas	COBOL	1	Prj Mgr	1	31.00	A/R	Jonas
Jonas	Pascal	3	Prj Mgr	1	31.00	A/R	Jonas

Table 2: *PERSONNEL2, the data from PERSONNEL1 arranged into first normal form.*

Data Dependencies

If, for each row, the value of a column A1 uniquely determines the value of a column A2, then A2 is *functionally dependent* on A1. For example, in PERSONNEL1, since each employee has only one position we may say that EMP determines POS, and that POS is functionally dependent on EMP. If the value in column A1 limits the possible values of column A2 to a specific set, then A2 is *set dependent* on A1. PRJ is set dependent on EMP, because each employee is assigned to a specific set of projects. Figure 1 illustrates the dependencies in the sample data by using single-headed arrows to show functional dependence and double-headed arrows to show set dependence. This dependence diagram allows the problem of PERSONNEL2 to be clearly visualized.

The remaining problems are all violations of the following rule:

RULE 2: *In every row, each column must be dependent on every part of the key.*

For example, the columns POS, EXP, and PAY are not dependent on the entire key of PERSONNEL2. These

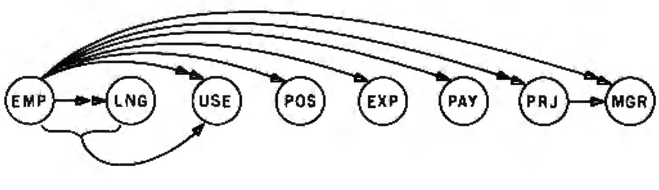

Figure 1: *This diagram illustrates the two types of data dependencies. The single-headed arrows show functional dependence and the double-headed arrows show set dependence.*

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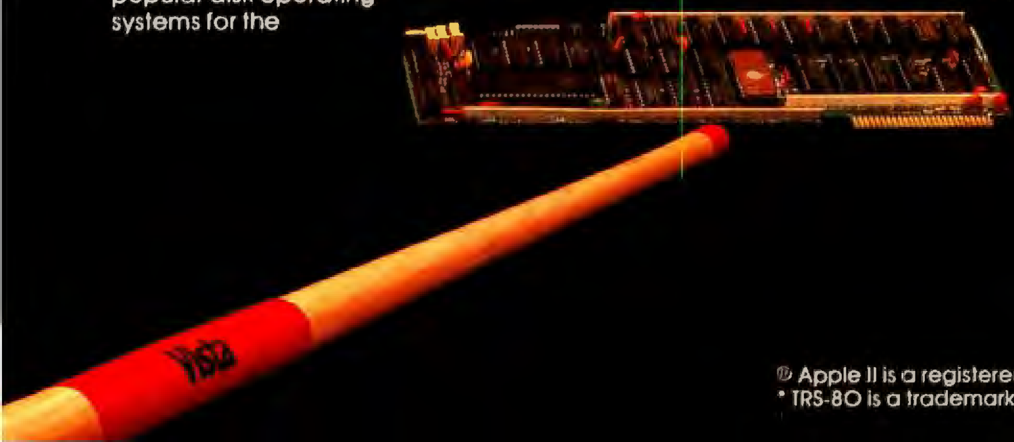

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EMP	POS	EXP	PAY
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Dalton	Sr Prog	3	24.00
Fitch	Prj Mgr	2	32.50
James	Sys Anl	2	29.00
Jonas	Prj Mgr	1	31.00

BACKGROUND:

EMP	LNG	USE
Bogard	COBOL	3
Bogard	FORTRAN	2
Dalton	COBOL	2
Dalton	PL/I	1
Dalton	RPG	3
Fitch	COBOL	4
James	COBOL	5
James	GPSS	2
Jonas	AMBIT	1
Jonas	BLISS	2
Jonas	COBOL	1
Jonas	Pascal	3

Table 3: *The data from PERSONNEL2 in second normal form. This format was achieved by splitting the relation so that there is no partial key dependence.*

columns are determined by EMP alone, so we will form a new relation, PERSONNEL3 (see table 3), containing only EMP, POS, EXP, and PAY, having EMP as a key.

The value of USE is determined by both EMP and LNG, so a BACKGROUND relation (see table 3), having a composite key made of EMP and LNG, may be formed from these three columns. Since BACKGROUND contains EMP as a column, it will still be possible to associate

PERSONNEL4:

EMP	POS	EXP	PAY
Bogard	Sr Prog	4	25.00
Dalton	Sr Prog	3	24.00
Fitch	Prj Mgr	2	32.50
James	Sys Anl	2	29.00
Jonas	Prj Mgr	1	31.00

BACKGROUND:

EMP	LNG	USE
Bogard	COBOL	3
Bogard	FORTRAN	2
Dalton	COBOL	2
Dalton	PL/I	1
Dalton	RPG	3
Fitch	COBOL	4
James	COBOL	5
James	GPSS	2
Jonas	AMBIT	1
Jonas	BLISS	2
Jonas	COBOL	1
Jonas	Pascal	3

ASSIGNMENTS:

EMP	PRJ
Bogard	A/R
Bogard	Payroll
Dalton	Inventory
Fitch	Inventory
James	A/R
James	Datacomm
Jonas	A/R

PROJECTS:

PRJ	MGR
A/R	Jonas
Datacomm	Spivey
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Payroll	Smith

Table 4: *Our final goal—the third normal form. The data from table 3 are further split into a multi-tabular format to eliminate any transitive dependencies.*

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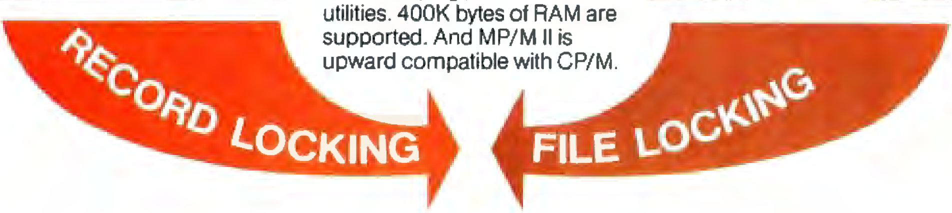

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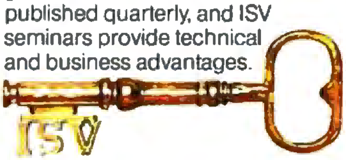

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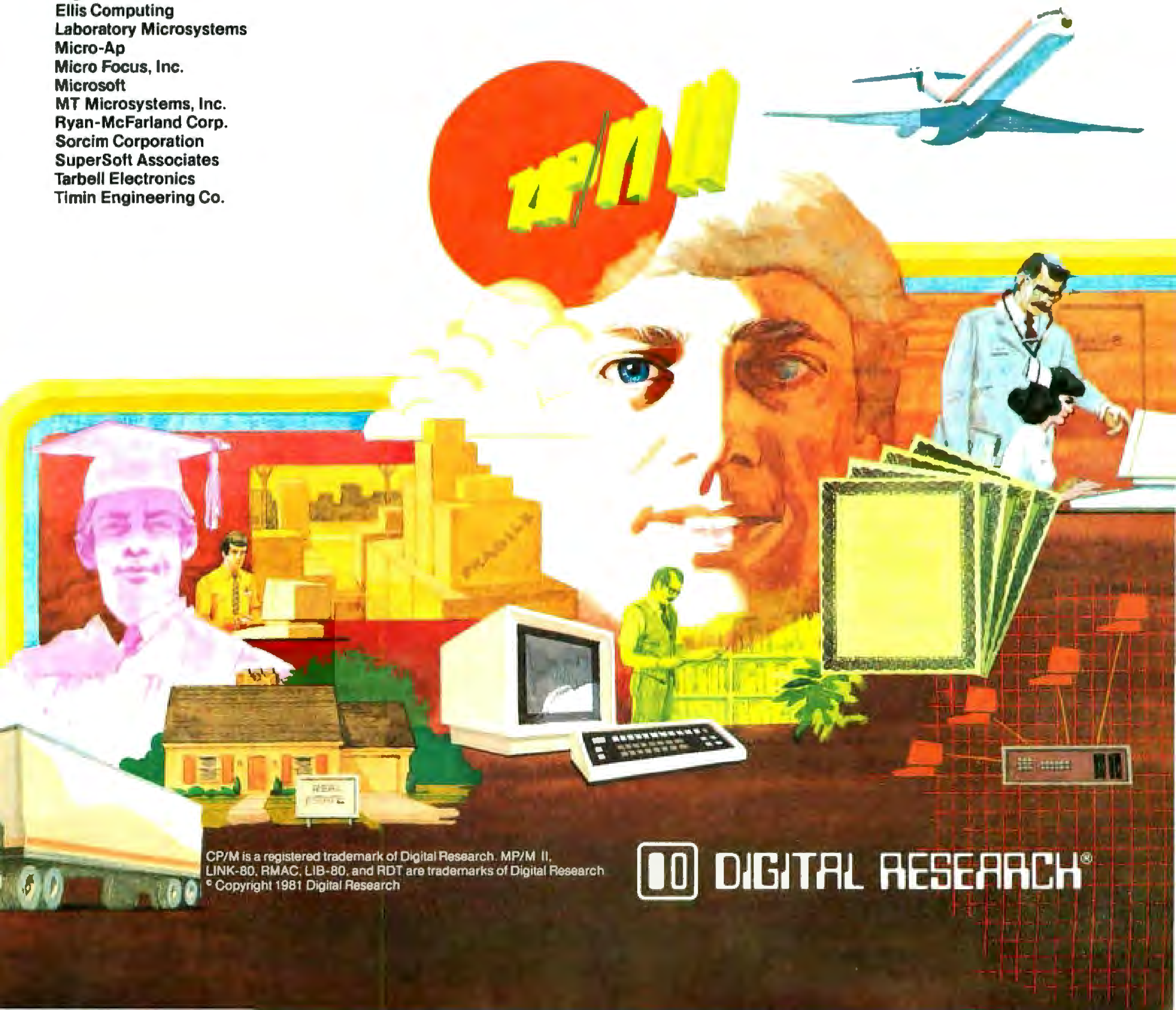

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an employee's language experience with personnel data for that employee.

Splitting the Relation

Splitting the relation, as illustrated in table 3, prevents the experience part of the model from having columns that are dependent on only part of the key. A first-normal-form relation (simple values in each position of the table) that also has no partial key dependence is said to be in second normal form.

The situation with project assignments is slightly different. The employee name determines the set of projects on which that employee works, independent of the languages used by that employee. This means that a relation containing PRJ should not have LNG in its key. However, the project name uniquely determines the project manager. MGR is *transitively dependent* on EMP, since EMP determines a set of values for PRJ, and PRJ, in turn, functionally determines MGR. This transitive dependence must also be removed, according to the following rule:

RULE 3: *In every row, all columns must depend directly on the key, without any transitive dependencies through other columns.*

Because each project has only one manager, we will form the PROJECTS relation (see table 4) from columns PRJ and MGR, using PRJ as the key. (MGR could also be a key if each employee managed only one project.)

Finally, since each employee works on one or more projects, a relation called ASSIGNMENTS (see table 4) may be constructed from EMP and PRJ to form the association between PERSONNEL3 and PROJECTS. Notice that PROJECTS is "all key" with no additional dependent columns. This is due to the fact the only thing dependent on both EMP and PRJ is the fact that they are associated. An association between relations is frequently represented in this way.

A second-normal-form relation that has no transitive dependence is said to be in third normal form. All relations in the data model of table 4 are in third normal form.

At this point, the design has evolved to the point where all of the difficult queries mentioned for the initial structure are easy to fulfill. By selecting all rows of BACKGROUND with a given value of LNG, all programmers who can use a specific language may be located. Accessing ASSIGNMENTS with a given PRJ identifies all programmers on the project. Since PROJECTS is now a separate relation, associating a project with its manager, for retrieval or change, is easy. It is equally easy to find which projects a project manager is supervising.

Using the Third Normal Form

As an example of the simplicity and flexibility of third normal form, consider the query "What is the COBOL experience of senior programmers working on any project managed by Fitch?" One approach, using the structure of table 4, would be:

1. Look in PROJECTS to find that Fitch manages the Inventory project.
2. Use ASSIGNMENTS to find that Fitch and Dalton work on Inventory.
3. From PERSONNEL4 for Fitch and Dalton, discover that Dalton is the only senior programmer.
4. Using BACKGROUND, find that Dalton has two years experience with COBOL.

By selecting one or more rows from a relation, then using column values to select from further relations, as needed, you can use the data with a high degree of flexibility. This makes it far easier to handle the unanticipated "Oh, by the way, can the computer tell me . . ." requests that invariably occur after a system has been implemented.

In Summary

Our purpose here has been to examine the data-organization aspects of the relational model. The relational concept also contains a rigorously defined set of operations that may be used to manipulate and combine relations in an algebraic fashion.

We cannot overemphasize that the relational model is concerned with a logical view of the data—apart from the physical representation used to store the data. Using only the abilities to construct multiple keys to the same data file and to find the first key greater than (or equal to) a given trial key, relational data organization may be implemented quite easily.

Although table 4 has the appearance of wasteful duplication in the stored data, a real application would likely encode all occurrences of a costly-to-store column like POS by an internal code (possibly one byte in length). Employees would most likely be identified by a unique employee code instead of by name. Thus it would be possible to have the advantages of relational organization without unreasonably high storage overhead.

In addition to the three normalization steps discussed here, there is a fourth normal form that arises in connection with certain types of complex key interdependencies. (The interested reader may find further discussion in the references.)■

References

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2. Kroenke, David. *Database: A Professional's Primer* Chicago IL: SRA, 1978. Kroenke offers an interesting comparative analysis of existing commercial data-base management software.
3. Martin, James. *Computer Data-Base Organization*. Englewood Cliffs NJ: Prentice-Hall, 1977. Martin gives an excellent set of examples for the reader who is unfamiliar with data-base organization.

Build a Bar-Code Scanner Inexpensively

Bradley W Bennett
238D Vairo Blvd
State College PA 16801

Printed bar-coded software has come one step closer to being a practical reality. I began to realize this after reading an item entitled "Hewlett-Packard Introduces High-Resolution Optical Reflective Sensor" (November 1979 BYTE, "What's New" column), which announced the production of the HEDS-1000 integrated high-resolution sensor.

I waited, expecting a complete and relatively simple "scanning wand" that would be suitable for reading bar-codes. Confirmation was given on the cover of the April 1980 BYTE—Hewlett-Packard announced the HEDS-3000 Digital Wand, a fine product for those who can afford to spend $99.50. While the price is fair, as a graduate student on a fixed budget I sought a less expensive bar-code reader.

As an alternative, I constructed a homebrew bar-code scanner, based on the HEDS-1000 sensor. The do-it-yourself scanner is reliable, easily constructed, and, best of all, costs about $35 (including the $29 sensor). For those who are willing to spend time, rather than money, it represents a practical alternative to the preassembled units.

The HEDS-1000 optoreflective sensor is the eye of the scanner. Hewlett-Packard has incorporated a 700 nm (nanometer) light source, a photodiode detector, and the necessary focusing optics to detect *reflecting* and *absorbing* characters in a single package. As a bonus, the unit also includes an NPN transistor that can be optionally wired as a first single-stage high-gain amplifier. The internal connection diagram of the HEDS-1000 is illustrated in figure 1.

The only other operational requirement in addition to some elementary op-amp (operational amplifier) interfacing is that the distance between the front of the sensor and the printed page be kept at approximately 4.34 mm (0.171 inch). When set at this distance the sensor is capable of resolving a 0.190 mm (0.075 inch) spot size, which is less than half the width of a normal bar-code unit. Significant departure from this setting results in loss of resolution and, if taken to extremes, complete loss of detection.

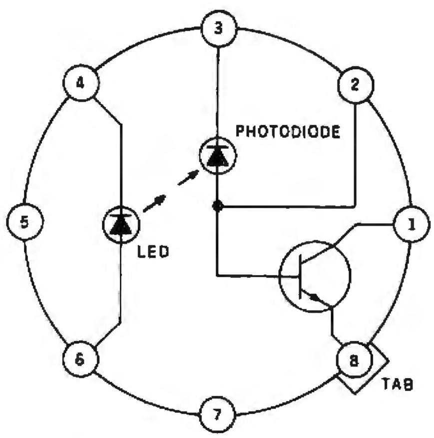

Figure 1: *Pin arrangement of Hewlett-Packard's HEDS-1000 optical reflective sensor. A light-emitting diode, photodiode, NPN transistor, and focusing optics are combined in this single package.*

In addition to these technical requirements, the sensor should be housed in a body that fits comfortably in the human hand, is easy to construct, and is (of course) inexpensive. I decided to use the body of a ball-point pen. The "fat pens" produced by a couple of manufacturers are an ideal choice. I selected the Schaefer No Nonsense pen for the wand because it provided a sufficient amount of room in the tip. Its barrel is in two pieces that screw together, and when not in use, the screw-on cap makes an excellent protective cover for the sensor.

Construction

The first step in construction involves disassembly and modification of the pen barrel. At the top of the pen is a spring, which is easily removed by drilling out from the top side. This modification becomes useful later, as it allows the scanner

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cable to exit from the top. Select a drill bit that will allow one half of a grommet to be inserted and glued into the barrel top. Slightly lower on the side of the barrel, drill a hole of similar size for the other half of the grommet, in which will be placed an LED (light-emitting diode). These modifications are shown in figure 2a. Although the indicator LED is optional, it does provide a convenient monitor of the wand's operation.

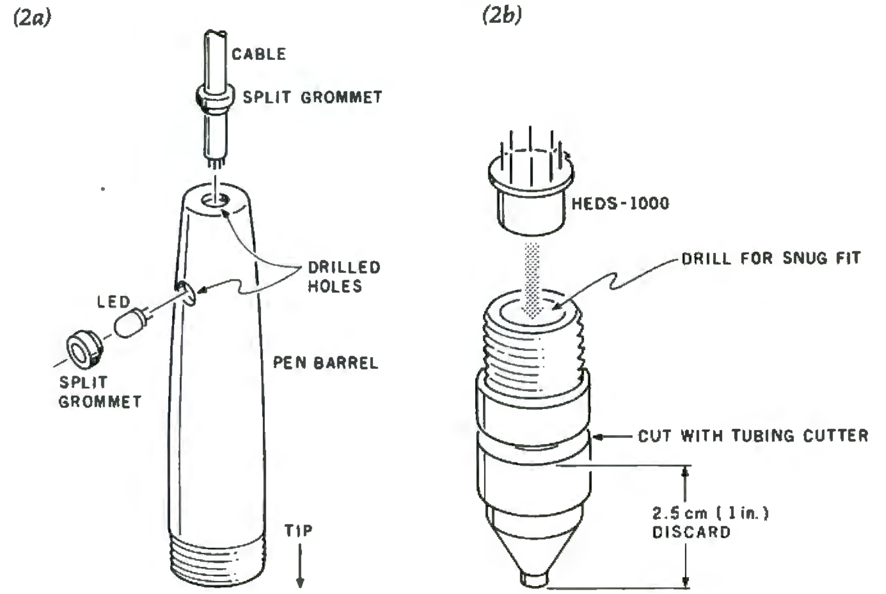

Figure 2: *Modifications made to Schaefer No Nonsense pen barrel. With contents removed, the pen becomes a home for the HEDS-1000 sensor. The cable and indicator LED are affixed to the pen barrel (2a), while the sensor is mounted to the pen tip (2b).*

A critical design factor is the number of conductors in the scanner cable. My scanner employs a five-conductor cable, which permits all interfacing to be done externally from the wand. This could have been reduced to four conductors had I placed the HEDS-1000 LED current-limiting resistor (R1) inside the barrel. In fact, I did try to place the entire circuit within the pen barrel, but it was obvious that a short circuit between pin 6 and a positive power-supply terminal was a strong possibility with such a crowded arrangement. (Burning out the LED within the sensor makes the sensor little more than an expensive phototransistor.)

If you are limited to a three-conductor cable, I suggest you eliminate the barrel-mounted indicator LED and move R1 inside the barrel. By keeping the rest of the circuitry outside of the barrel, the circuit can easily be fine tuned.

Modifications to the pen tip are shown in figure 2b. The simplest way to make a clean cut, perpendicular to the pen's axis, is with a small tubing cutter. Although not absolutely critical, the cut should be made about 2.5 cm (1.0 inch) from the tip end. This will insure that enough of the threaded part of the tip remains to securely hold the sensor while permitting adjustment of the sensor-to-reflector distance. After cutting, the threaded end of the tip should be carefully drilled out so the sensor can be pressed in snugly.

Again, it is important that the distance from the sensor's front surface to the tip's cut face be kept at approximately 4.34 mm (0.171 inch). I found this easiest to do by making a calibration cylinder exactly 4.34 mm long, which fits inside the tip opening. The diameter of the cylinder must be large enough to make contact only with the sensor's metal can, and it must not obscure the transparent filter. Successively lapping the end of

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a suitable piece of aluminum rod over fine emery paper will quickly achieve the required height.

Before seating the sensor at this distance with a small drop of epoxy, the small indexing tab above pin 8 must be removed so that the tip assembly can be threaded into the barrel. Careful filing does the trick. The leads should also be trimmed to guard against electrical shorting after assembly.

At this point, all that remains is to solder the cable leads and complete final assembly. In addition to soldering the cable connections on the sensor, solder a wire between pins 4 and 8 and extend it another 10 cm (4 inches). This is the ground lead for the side-mounted LED. Carefully screw the tip assembly into the barrel while rotating the cable with the tip assembly. This is easier to accomplish with two people: one holds the cable and tip assembly, the other turns the barrel.

Fish the indicator LED's ground and cable lines through the side hole and half-grommet and solder them to the LED's shortened leads. Place a small drop of epoxy on the LED and half-grommet and press them into the side hole from the outside. The scanning wand is now complete. The finished product, with calibration cylinder, appears in photo 1.

Sensing Circuit

As shown in figure 3, the circuitry to make the sensor's output TTL- (transistor transistor-logic) compatible requires only two integrated circuits. Three op amps in the LM324 packages handle amplification and comparative functions, while the 7413 NAND Schmitt trigger "cleans up" the sensor's output by only passing pulses above a threshold voltage. To stabilize the common-collector circuit using the sensor's NPN transistor, a 15 pF capacitor and 1 megohm resistor are put in parallel with the transistor. Nominal outputs at this stage are approximately +3.2 V for a light-absorbing surface (black) and +1.7 V for a reflecting surface (white). These values can be adjusted by varying resistor R10.

Photo 1: *Author's bar-code scanning wand. The wand is based on Hewlett-Packard's HEDS-1000 optical reflective sensor (the metal can with eight pins), and a Schaefer No Nonsense ball-point pen. The calibration cylinder appears at the right of the HEDS-1000 module.*

The signal is fed to the inverting input of one of the LM324's op amps, which is configured as a comparator. The amplifier's other input receives a reference voltage set through the voltage divider of R3 and R4. The divider network should be adjusted so that this input to the amplifier is about +2.5 V, which will ensure that the scanner produces on and off pulses approximately equal in length (while scanning equally sized absorbing and reflecting characters).

The output of the first op-amp stage is coupled to the inverting input of the second op-amp comparator, which drives the scanner's LED. The first stage's output is also sent to a voltage follower that drives a NAND Schmitt trigger. Besides functioning as an inverter, the Schmitt trigger provides a sharp output that is filtered by the 1000 pF capacitor. Although the addition of this capacitor does cut down on response time when scanning at extremely high rates, it poses no problem for practical hand scanning.

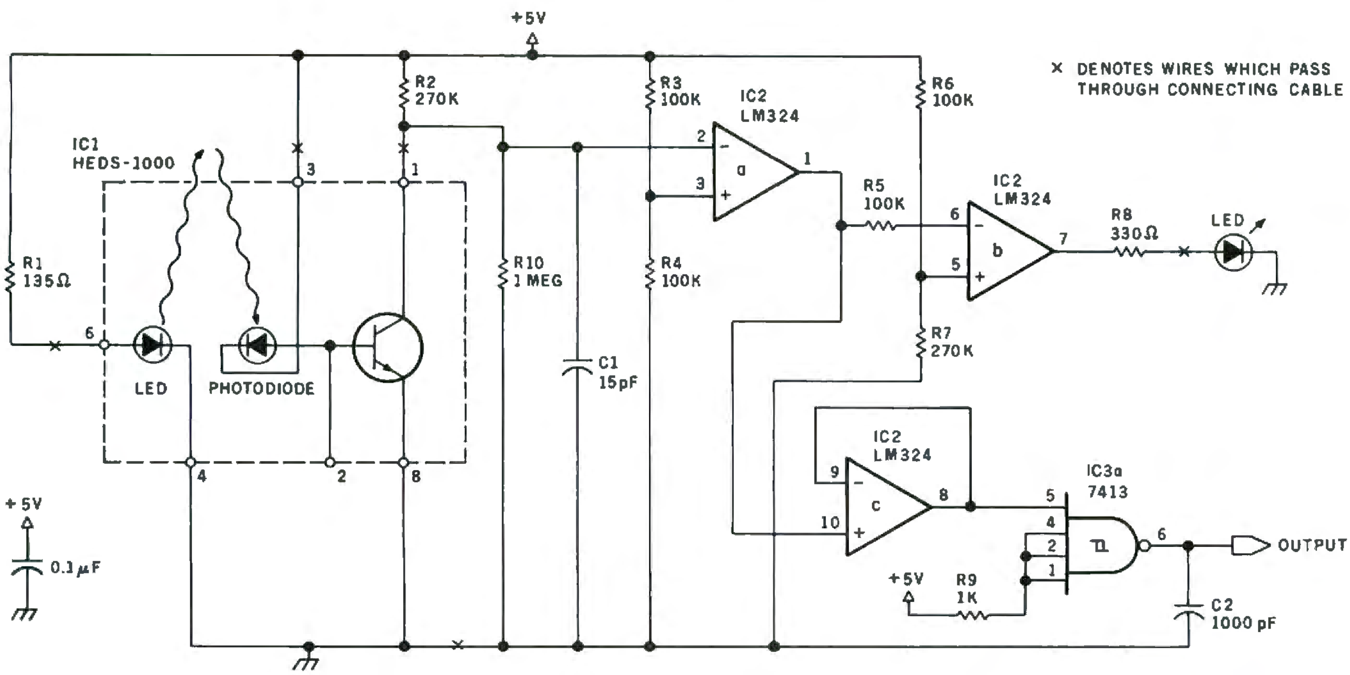

Figure 3: *Schematic diagram of the circuit to make the sensor's output compatible with transistor-transistor logic. The sensor's integral NPN transistor is connected as an amplifier/driver. One section of an LM324 quad-operational amplifier is connected as an inverting comparator. The output of this stage is fed to the indicator LED (mounted on the pen barrel) through a second amplifier section. The signal also goes to a voltage-follower-connected op amp that drives a Schmitt-trigger NAND gate. The NAND gate's sharp output pulse is filtered with a 1000 pF capacitor.*

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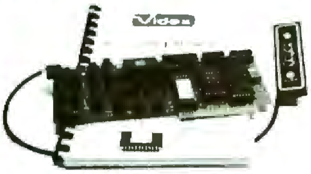

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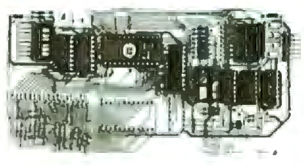

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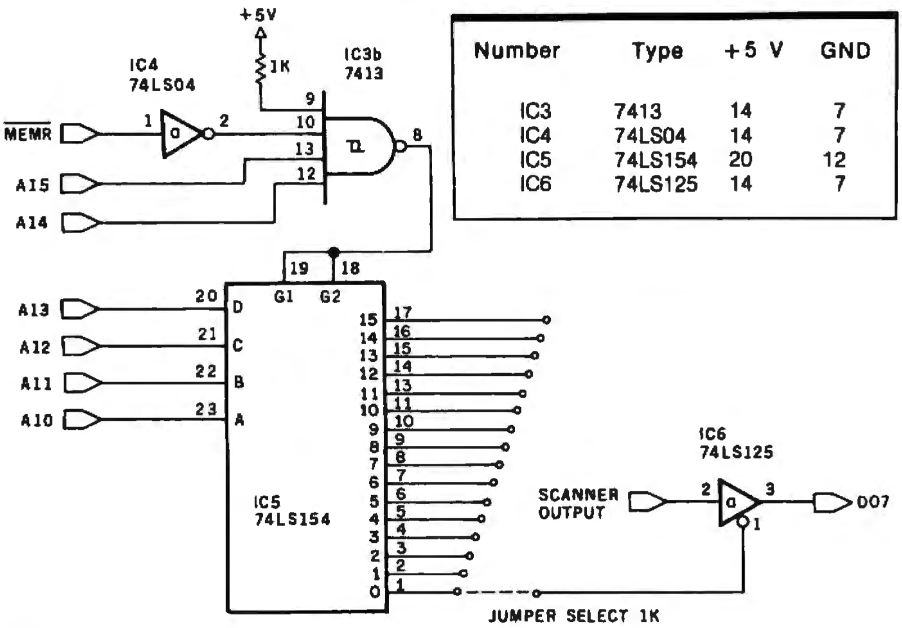

Number	Type	+5 V	GND
IC3	7413	14	7
IC4	74LS04	14	7
IC5	74LS154	20	12
IC6	74LS125	14	7

Figure 4: *Memory-mapped interface to the signal bus of a microcomputer. The decoding circuitry will gate the bar-code scanner's output onto the data bus whenever an address within the selected 1 K-byte space is accessed by a memory-reference instruction. In this arrangement, the 1 K-byte space resides somewhere in the top 16 K bytes of the address space. (This interface is compatible with the software presented in Ken Budnick's book* Bar Code Loader.*)*

That's all there is to making a simple bar-code scanner. The circuit in figure 4 illustrates an extremely simple interface to an 8-bit microcomputer bus. The signal from the wand's output is gated onto the computer's data bus through a memory-mapped addressing scheme. The wand's output will be available when a memory-reference instruction is executed addressing a 1 K-byte block anywhere in the top 16 K bytes of address space (the specific block is selected by a jumper connection). The high-order bit on the data bus receives the signal.

Ken Budnick's book *Bar Code Loader* (available from BYTE Books) contains bar-decoding programs for the 8080, 6800, and 6502 microprocessors which read the high-order data bit. Due to their simplicity, the routines can be easily modified to work in almost any system.

One comment should be made concerning this software. Even on my slow 2.048 MHz 8080A-based system, I found it was impossible to scan fast enough to keep the counting register from timing out (the register exceeded the counting limit of 255). By adding a DCR...JNZ (decrement register...jump on not zero) loop in the input scanner sections of the software, I solved the problem. I suspect that similar changes will have to be made to the software for other systems. Note that the addition of this time-killing loop does not result in a significant reduction in practical hand-held scanning speeds—I accurately and reproducibly scan at more than 25 cm (10 inches) per second.

Bar codes represent a reliable and convenient method of mass-distributing digital information. Hewlett-Packard's design and production of the HEDS-1000 sensor makes bar-code reading practical for me. Combining it with some simple interfacing has made printed software a reality. ■

The HEDS-1000 optical-reflective sensor can be ordered from Hamilton-Avnet, 1175 Bordeaux Dr, Sunnyvale CA 94086. Address orders to Sales Department.

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- Mathematical and scientific functions accurate to 8 decimal places
- Unique one-touch entry of key words like PRINT, RUN and LIST
- Automatic syntax error detection and easy editing
- Randomize function useful for both games and serious applications
- Built-in interface for ZX Printer
- 1K of memory expandable to 16K

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*Plus shipping and handling. Price includes connectors for TV and cassette, AC adaptor, and FREE manual.

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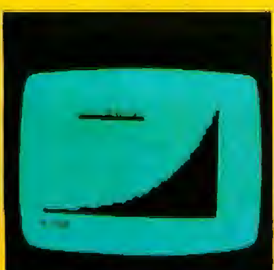

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ZX81 MANUAL: The ZX81 comes with a comprehensive 164-page programming guide and operating manual designed for both beginners and experienced computer users. A $10.95 value, it's yours free with the ZX81.

Reversal

Othello for the Apple II

Mark Friedman
23 Forge Dr
Nashua NH 03060

"Winner of the software division of the First International Man-Machine Othello Tournament" is the declaration that catches your eye when you pick up the box. And if that's not intimidating enough to a casual game player, consider that Reversal is written by the Spracklens of Sargon chess fame. Is there any hope of winning? The answer is a most emphatic yes, depending on the level of play you select. At the same time, however, Reversal is capable of giving even the best player a tough run for the money.

The game is played on an eight-by-eight square board, and the object is to occupy more squares than your opponent. The game's rules are very simple: you place one piece on the board per turn and try to trap your opponent's pieces between your own; all pieces trapped become yours. It sounds simple, and, as any Othello player knows, it is . . . sometimes.

Reversal comes in the now standard Hayden Gameware box, with a better-than-average instruction booklet and a registration card. The disk carries what seems to be its own operating system, as well as the game itself, and is, of course, both write-protected and "uncopyable." At least the few casual efforts I made to copy it failed. The registration card indicates that if your original disk becomes unusable in less than a year, it will be replaced free of charge. The instruction booklet, however, states that replacement will be free for 90 days, after which a copy will cost $5.

Loading Reversal is simple, although a mention of its 13-sector status would make the first time even easier for those with systems that default to a 16-sector format. It might also make you feel a little better if you were warned that several head initializations, with their usual clatter, are normal (at least they were on my system, with any drive I used). Once loaded, you are offered four choices: play a game against your Apple II; start a game with any given board layout; play against a fellow human; or exit from the program. Be forewarned that exiting delivers you into the hands of the Monitor program. You should also be aware that the instruction booklet is written in a tutorial style, which is fine for a first reading, but a table of available commands would make life easier a week later.

If you elect to play a game, you are asked several ques-

Othello is a trademark of CBS.

At a Glance

Name
Reversal

Type
High-resolution graphics game playing a version of Othello

Manufacturer
Hayden Book Company
50 Essex St
Rochelle Park NJ 07662
(800) 821-3777

Price
$29.95 tape; $34.95 disk

Format
Apple cassette or 5-inch Apple floppy disk

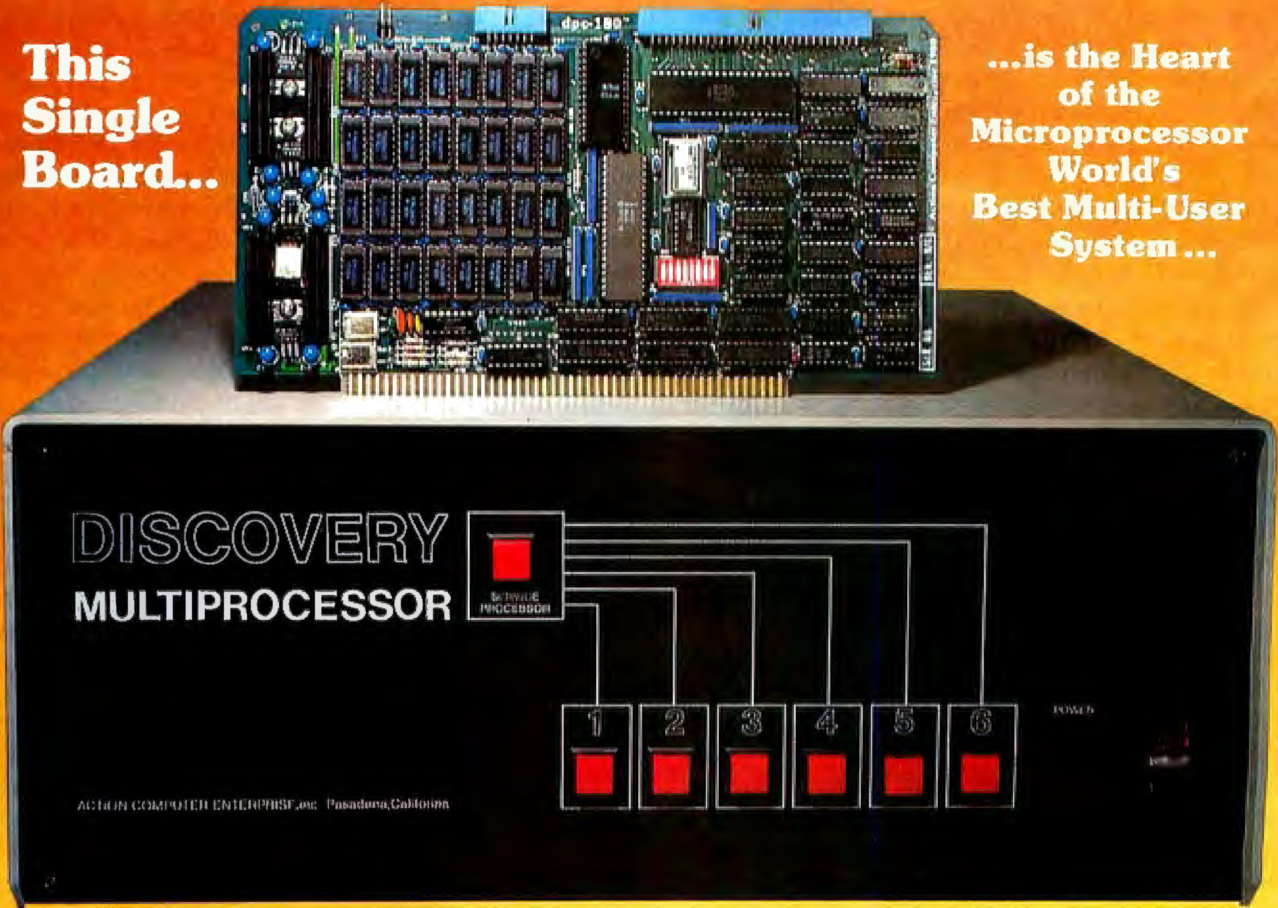
Language
Assembler

Computer
Apple II with at least 32K bytes of memory; tape or disk drive; video monitor or TV

Documentation
14-page booklet

Audience
Game enthusiasts of all ages, Othello enthusiasts in particular

This Single Board...



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*CP/M is a registered TM of Digital Research, Inc.

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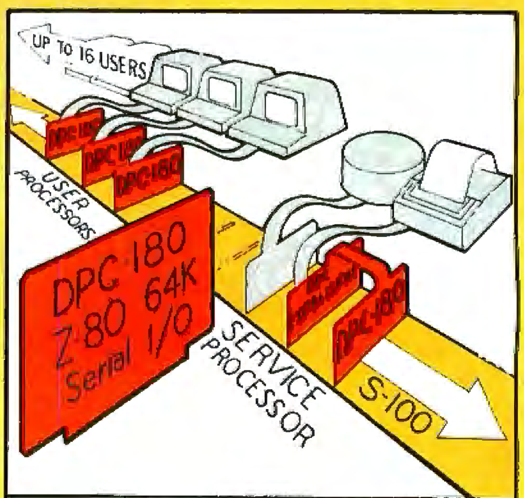

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Action Computer Enterprise, Inc.
The Multiprocessing Company

55 West Del Mar Boulevard, Pasadena, California 91105 USA ● Cable ACEPAS Pasadena ● (213) 793-2440

tions. The first is which color, black or white, you wish to play. The two remaining questions determine the program's level of play. Your first decision is to select the level of strategy the program will use, with choices of beginner, intermediate, and advanced (advanced is billed as its championship level). Your last decision is how much time to allow the program to determine its next move. There are nine time levels, listed as ranging from 2.5 seconds to 30 minutes, providing a total of 27 playing levels for the program—more than enough to suit any level of player.

Be aware of two things while selecting the program's play level. The first is that the printed list of "approximate" response times is *very* approximate. Level 6, with a listed time of one minute, varied from just under a minute to almost three minutes during one game played at the advanced strategy level. The second detail is that while the strategy level you pick cannot change during a game, the response-time level can be changed at any time, making play even more flexible.

Reversal makes use of both the text and graphics displays during execution, showing the level of play and move list on the text page and the board itself on the graphics page. Toggling between the two displays is done with the ESC (escape) key, although once a game has started, I've found little need for the text display other than to record a game for posterity. Reversal makes good use of the Apple's graphics, with a couple of nice touches like pieces that smile or frown depending on the score (when both sides are tied, they just stare at you). Should you find them distracting, the faces can be turned off.

Once you are looking at the game board, playing is as simple as it can be—at least the mechanics are. There is no need to memorize a list of board locations, as navigation is done with the cursor-control arrows. In addition, since the cursor will stop only on squares that represent legal moves, there is really no excuse for overlooking a possible move. Once you have found the square you would like to move to, just press Return. All trapped pieces will be flipped automatically, and the score, displayed on the sides of the screen, will be updated, as will the move list displayed on the text page. The program then begins its search for a suitable response.

Reversal is so easy to play that my five-year-old daughter was able to play her first game after five minutes of coaching. While her first game was a bit of a rout, she insisted on playing until she won, several times.

I tend to be a casual, rather than an aggressive, player, and my selection of playing levels reflected that. I got the most pleasure playing at the lower, faster-response levels, with a few highest-level (30-minute response) games thrown in for good measure. To compare the strategy levels, I played a series of games at each level. While I was able to win the majority of games at the beginner level, and half or more at intermediate, the advanced level was easily my match. In fact, one game played at

level A6 was the most elegant example of trap-setting I have seen in a long time. Any time I can be beaten in the last five moves as badly as 63 to 1, I know I've met my match. That game made me wish there was a command to print the entire move list, rather than having to copy it by hand during the game—the game was over before I realized it was worth saving.

The program has two additional features that can make for a more varied game: the ability to take back any move and a way to ask what the program thinks your best move is. It can sometimes take an extreme effort of will not to back a game up to where you made some "mistake," but it can be fun to check out other possibilities, and it's nice to know you can. The ability to ask the program about your best move is also a nice idea, but because it is limited by the amount of look-ahead the program did in computing its move, it is, more often than not, not your best possible response.

As there is no way to save a game in progress, the only way to resume an interrupted game is to record the positions of all pieces and use the facility to start a game from a given board layout, but this is a tedious process. A "Save Game" command would have solved the problem, particularly when playing at levels requiring 30 minutes per response.

As long as I'm "wishing," there are a few other things that either should be included or would be handy to have. These include the ability to change strategy level during a game, having the "Exit" command reload the system, and a table of commands in the instruction booklet. In passing, let me recommend the user's guide section entitled "Strategy Tips" to anyone who plays Reversal. The tips may be obvious, but they're valuable nonetheless.

I highly recommend Reversal to anyone who enjoys Othello or to anyone who likes strategy games in general. Reversal can also serve as a good introductory computer game for beginners of any age. The Spracklens have done a magnificent job: Reversal is everything I expected it to be when I saw who had brought it into the world.

Conclusions

- Reversal is capable of competing evenly with players of any level.
- Instructions and documentation for Reversal are better than average, but a "quick reference" table of commands would help inexperienced users. Running the game is complicated by only one fact: it is assumed you know that the disk uses Apple's DOS 3.2. An unusually large number of disk accesses occur before anything happens, so the first-time user might experience some anxiety.
- Use of graphics and the game paddle make this game well-engineered for human use, but a feature for saving unfinished games on disk would avoid making the player record, then reenter the positions of all the pieces. Other improvements could include allowing the player to change the strategy level during play and a command to end the game and reload the program. ■

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The Microcomputer as a Laboratory Instrument

Daniel Cosgrove
Botany Department
University of Washington
Seattle WA 98195

During the past three years we have actively used a microcomputer to study the biophysics of plant growth. The unit serves as a data-acquisition and stimulus-control system, as well as an analytical tool for processing and studying the resulting data. But why use a computer? Specifically, why use a microcomputer?

As a laboratory tool, the computer may be likened to a "smart" strip-chart recorder. That is, the computer not only stores data coming in from many different instruments (making it equivalent to not one but many chart recorders), but also controls external devices. For example, the microcomputer that we use in our laboratory regulates the timing and intensity of experimental light treatments given to plants. In addition, the computer permits easier, more subtle interpretations of the data involving mathematical transformations and statistical analysis.

In the past, such processes were severely limited by time and manpower. The availability of data in digital form makes sophisticated processing, such as signal averaging, smoothing, digital filtering, and curve-fitting, much easier. Thus the computer improves both the quantity and quality of experiments. In the last decade, the minicomputer has invaded the laboratory to perform these functions and more.

The reason for selecting a microcomputer is price—they sell for a fraction of the cost of a minicomputer. Yet in many cases they have all the required capabilities. Their biggest limitation in the laboratory is one of software—programs useful to the researcher are scarce. The first part of this article will give an overview of the microcomputer as it is used in our lab; this is followed by a description of the hardware and software architecture of the system.

System Overview

The primary use of our laboratory microcomputer (see photo 1) is to control experiments and acquire data. A typical experiment would involve the continuous measuring of the growth rate (and other parameters) of several plants over a 24- to 48-hour period, while subjecting the plants to various conditions such as light of different intensities or solutions of different osmotic strengths.

At the beginning of an experiment, the plants are connected to growth transducers, which are then connected to a multichannel A/D (analog-to-digital) converter in the computer. A BASIC program prompts the operator for the parameters of the experiment (eg: how many channels to sample, how often to sample, how many sampled points to average, when to turn the lights on and off, the total duration of the experiment) and feeds these values to the interrupt-driven

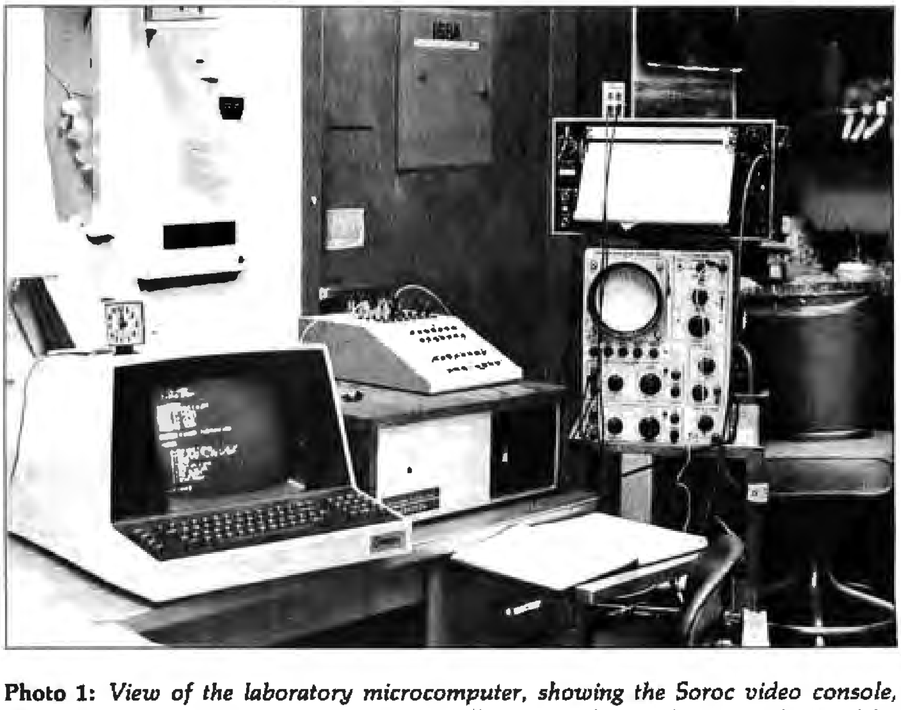

Photo 1: *View of the laboratory microcomputer, showing the Soroc video console, Horizon II computer, interface box, and oscilloscope and strip-chart recorder used for graphic display of data. Plant growth transducers and other instruments located in a controlled-temperature room behind the computer are plugged into the interface box on top of the Horizon.*

Acknowledgments
The author gratefully acknowledges the financial support of the National Science Foundation Graduate Fellowship, as well as the National Science Foundation Grant PCM 78-03244 awarded to Dr Paul Green of Stanford University.

assembly-language program that does the real work of the experiment. When the operator is satisfied with the experimental parameters, the BASIC program will start the sampling program.

Because the sampling program is an interrupt-driven routine, data acquisition can occur while BASIC works on a completely different program. This sampling will be completely transparent to the BASIC program and to the operator because the assembly routines are fast (the worst-case time required is less than one millisecond) and take up only a small portion of the processor's time (depending, of course, on the sampling rate), while the rest of the time is devoted to the BASIC (or other) program. This allows the operator to use BASIC for other tasks, or to run a program in BASIC that monitors the status of the experiment and permits the alteration of the progress of the experiment.

Using the video terminal, oscilloscope, or strip-chart recorder as display devices, this STATUS program can display the data collected by the sampling program. Photos 2 through 4 compare the three types of graphic displays. The oscilloscope and strip chart both have high resolution; the latter is used when hard copy is required. The video display has low resolution, but is useful when the other devices are not handy, and if you want to perform a simultaneous comparison of the data from different channels.

The data-acquistion programs are very flexible, allowing a wide range of sampling rates (up to three kHz) and control of up to sixteen different programmed events during the course of a sampling period. In addition, sampling periods may be automatically concatenated—with each period having its own parameters. I use this feature in my experiments on the effect of light on plant growth: high-frequency sampling during and shortly after the light treatment is alternated with lower-frequency sampling during the dark interval between light treatments. In addition, data points are averaged over a longer time span during the dark period, which saves both disk storage and processing time yet still provides the background growth-rate information I need.

After the computer has completed

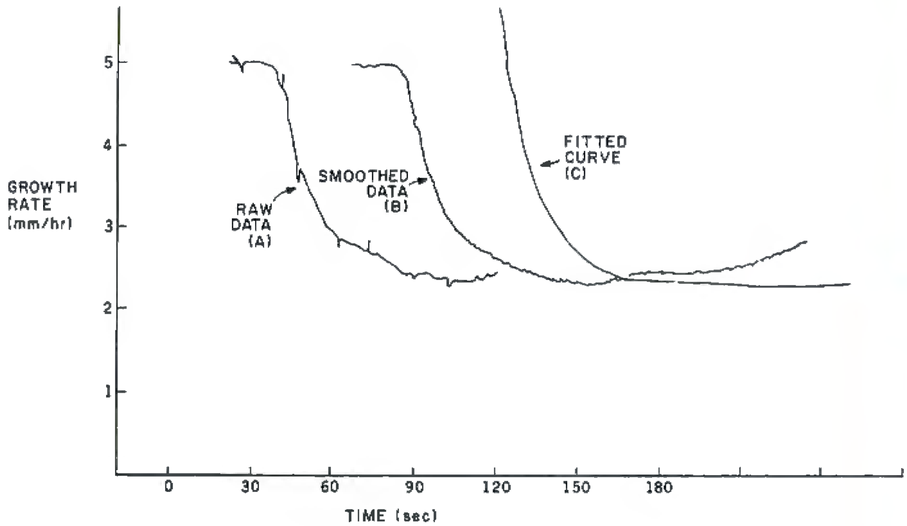

Figure 1: *Sample of data obtained using the acquisition system that appears in photo 1. The results of data smoothing and curve fitting performed on raw statistical data can be aided by the use of a microcomputer. Curve A shows the raw data of a plant's growth response to blue light; curve B shows the same data after smoothing to eliminate noise; curve C is derived from a computer fit of the data to an equation of an exponential decay of the growth rate to a lower rate.*

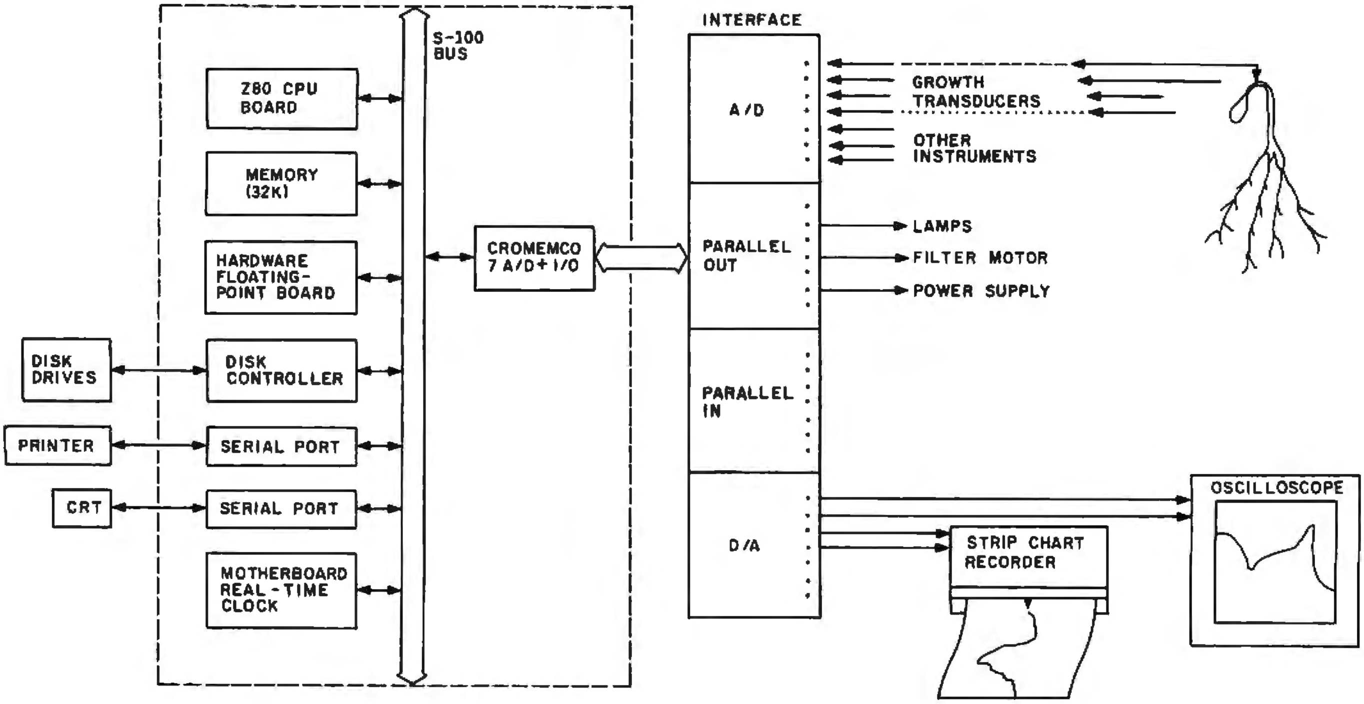

Figure 2: *Block diagram of the hardware and peripherals used in the author's data-acquisition system.*

an experiment, it can shut off its own power by activating a latching relay. The data that have been collected and stored on disk can subsequently be examined and processed. In our lab, such processing involves smoothing the data and fitting it to exponential curves using statistical methods. An example of this process appears in figure 1.

In the laboratory, the microcomputer is a powerful tool for data acquisition, processing, and analysis. The two major tasks involved in setting up such a tool are interfacing the computer to the lab instruments and writing the programs for data acquisition. These tasks are described in the following sections.

Hardware Requirements

What are the hardware requirements of the system? Figure 2 diagrams the setup. The microcomputer is a North Star Horizon, which uses the Zilog Z80A microprocessor as the central processor, with dual 5-inch floppy-disk drives and 32 K bytes of user memory as peripherals. The FPB (hardware floating-point board) is an optional peripheral that speeds up mathematical programs in BASIC. The Cromemco D+7A I/O (input/output) board provides a 7-channel A/D (analog-to-digital) converter for accepting voltage signals from lab instruments, a 7-channel D/A (digital-to-analog) converter for outputting the stored data to display devices, and an 8-bit parallel port used in the lab for turning external devices on and off.

An interface between the Cromemco board and the "real world" was built to protect the board from dangerous external voltages and to facilitate connecting instruments to it. The interface is shown in photo 5 and its schematic appears in figure 3. The analog inputs are protected by zener diodes that are in series with light-

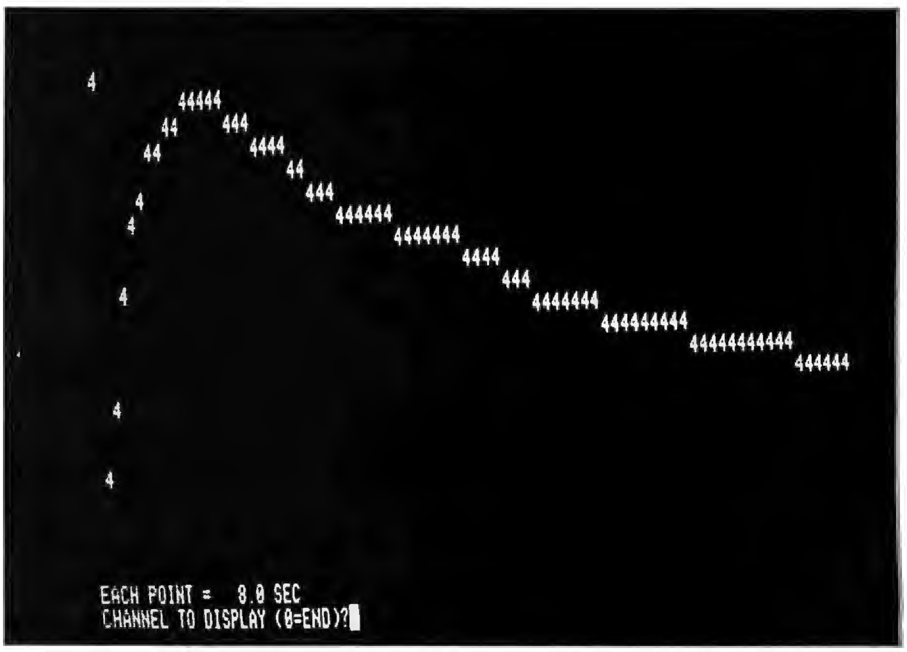

Photo 2: *Sample display of data on the Soroc system console using the terminal's direct X-Y cursor-positioning ability.*

emitting diodes. The zeners conduct current across the light-emitting diodes when the input voltage is outside the −2.7 to +2.7 V range. This protects the circuits on the A/D board and gives a visual signal to indicate either over- or undervoltage conditions.

The analog outputs are used for graphic displays of digital data by plugging an oscilloscope or strip-chart recorder into the output jacks on the interface box. The parallel port, which is used to turn lights and other devices on and off, is isolated from outside currents by optical couplers and reed relays. The reed relays can handle up to 0.75 A and 240 V. For the larger currents used by the 500 W lamps, the relays turn on triacs (bidirectional thyristors or silicon-controlled rectifiers) that can handle up to 15 A. (For those interested in reading more about interface circuits, I have included several references at the end of the article.) As you can see, most I/O for experiments is handled via the Cromemco board and its interface box.

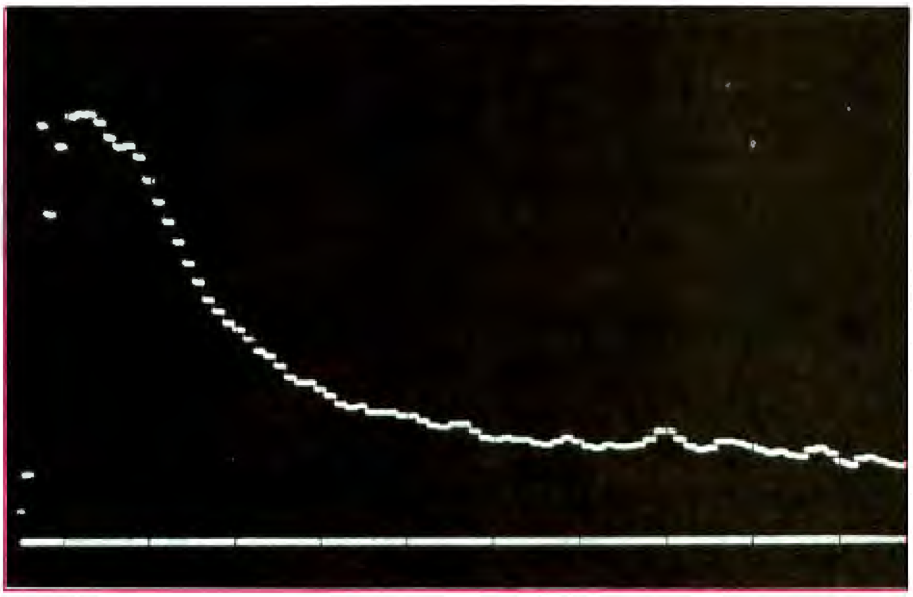

Photo 3: *Graphic display of data on the oscilloscope.*

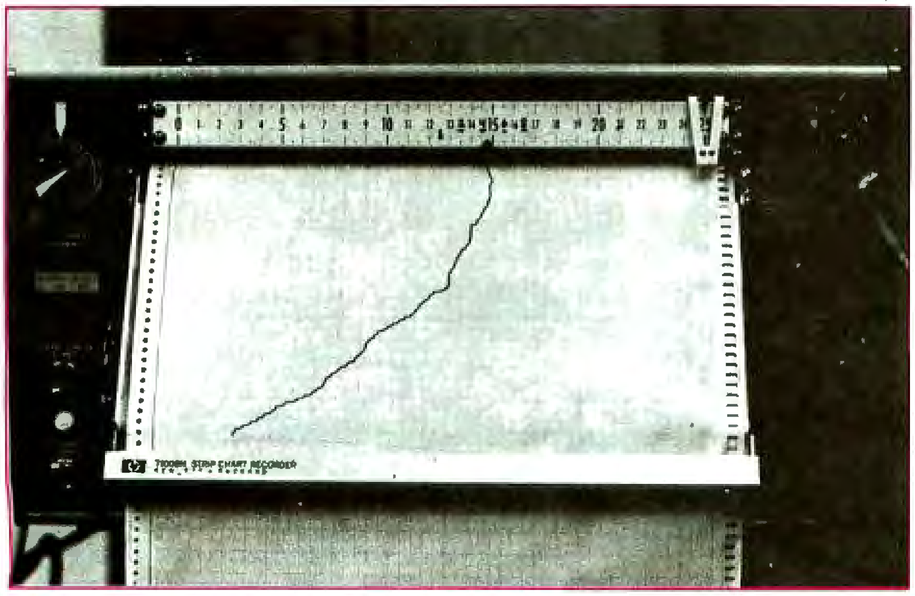

Photo 4: *Graphic display of data on the strip-chart recorder.*

The Horizon has a useful built-in interval timer (a so-called "real-time clock") located on the motherboard, which makes periodic sampling easy. To provide the clock-interrupt capability required by the data-acquisition program, the real-time clock flag is connected to one of the seven interrupt lines (V3) on the motherboard. The flag may then be enabled or disabled under program control (ie: it is armed while sampling is going on, but disarmed at other times).

One note of caution: whenever interrupts, either from the clock or other device, are enabled, the North Star Hardware Floating Point Board may not be used with reliability. In using North Star's special version of BASIC (called FPBASIC), which accesses the floating-point board, I found that the board sporadically returned erroneous results when interrupt sampling was occurring. (This happens when a clock interrupt falls in the middle of data transmission between the board and FPBASIC.) The sampled data, fortunately, is not affected, and use of standard BASIC instead of FPBASIC circumvents this problem.

Also to be considered is the fact that interrupts during disk activity may cause detected read errors as well as undetected write errors. As a consequence, the data-acquisition program described below always disables interrupts before attempting to write the data out to disk. This is necessary to insure error-free data transmission.

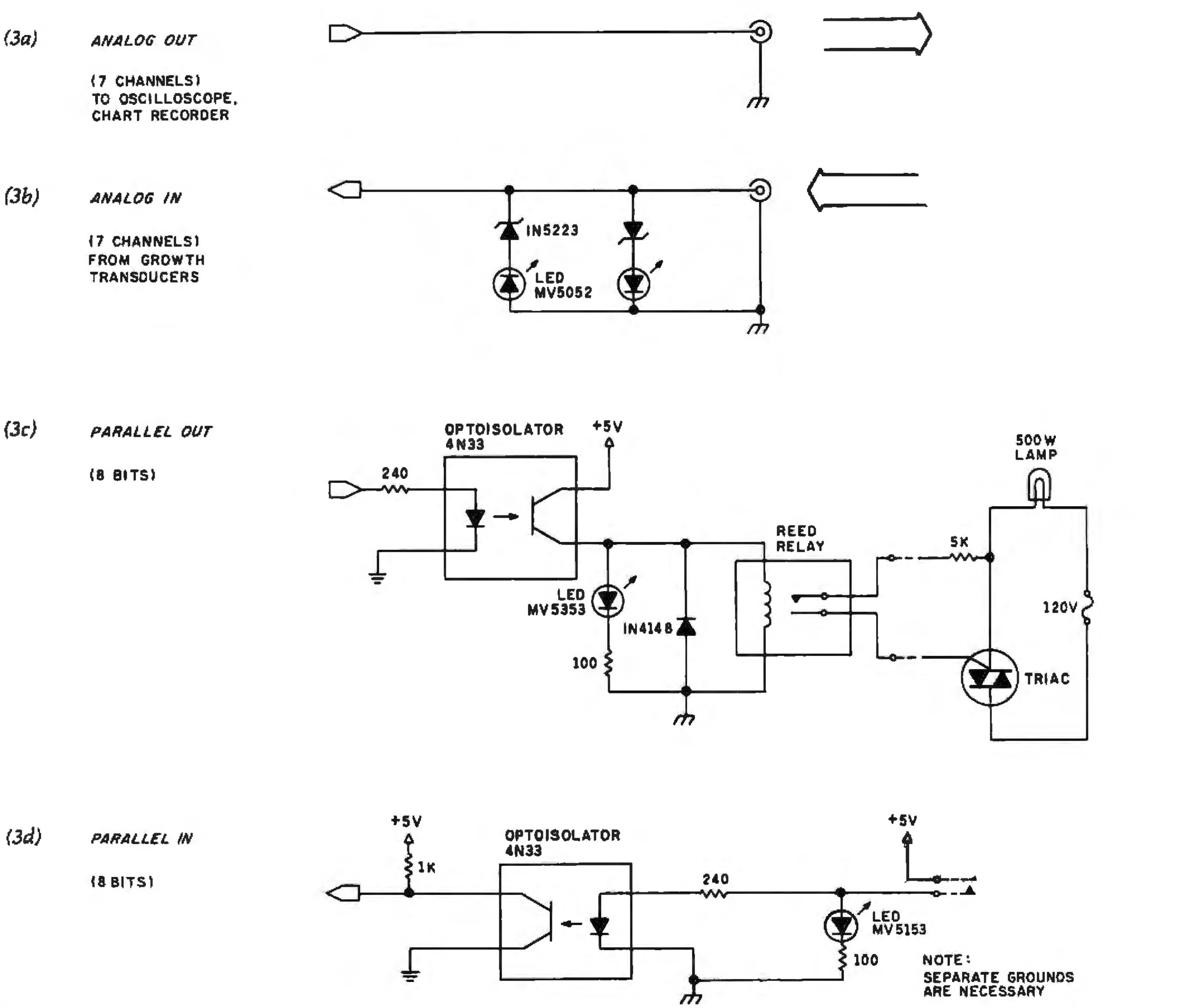

Figure 3: *Schematic diagrams of the four types of I/O channels used on the laboratory microcomputer. Figure 3a is the analog output from the Cromemco 7 A/D + I/O board to the graphics peripheral (this circuit is duplicated for 7 analog output channels). Figure 3b is the analog input interface that connects the Cromemco board to the various data-acquisition devices; the zener diodes protect the analog input circuitry on the board from overvoltages, while the LEDs indicate this danger condition (also duplicated for 7 channels). Figure 3c shows a relay controller operated from one bit of a parallel output port (duplicated for 8 channels). Figure 3d is the parallel input port interface (duplicated for 8 channels). Both of these interfaces protect the computer through the use of optical isolators.*

We use a Soroc IQ 120 terminal to communicate with the computer and a Teletype model ARS 33 as a printer.

Software Description

The special software used for laboratory experiments includes a variety of assembly-language programs as well as BASIC programs. The assembly-language data-acquisition programs (see listing 1) were developed using Xitan's (formerly TDL) editor and Z80 macroassembler under a CP/M operating-system environment. All of the programs were designed to use the North Star DOS (disk operating system) library routines for writing to and from disks. Similarly, all of the BASIC programs use North Star BASIC (see listings 2 through 4). The data-acquisition routines in machine language are located in a different portion of memory from that used by BASIC (see memory map in figure 4). Thus, both may function during an experiment.

For the purpose of maximum flexibility, the laboratory software was designed as a number of modules that pass information to each other. As seen in the left half of figure 5, the sampling programs consist of three main modules: INTERRUPT HAN-

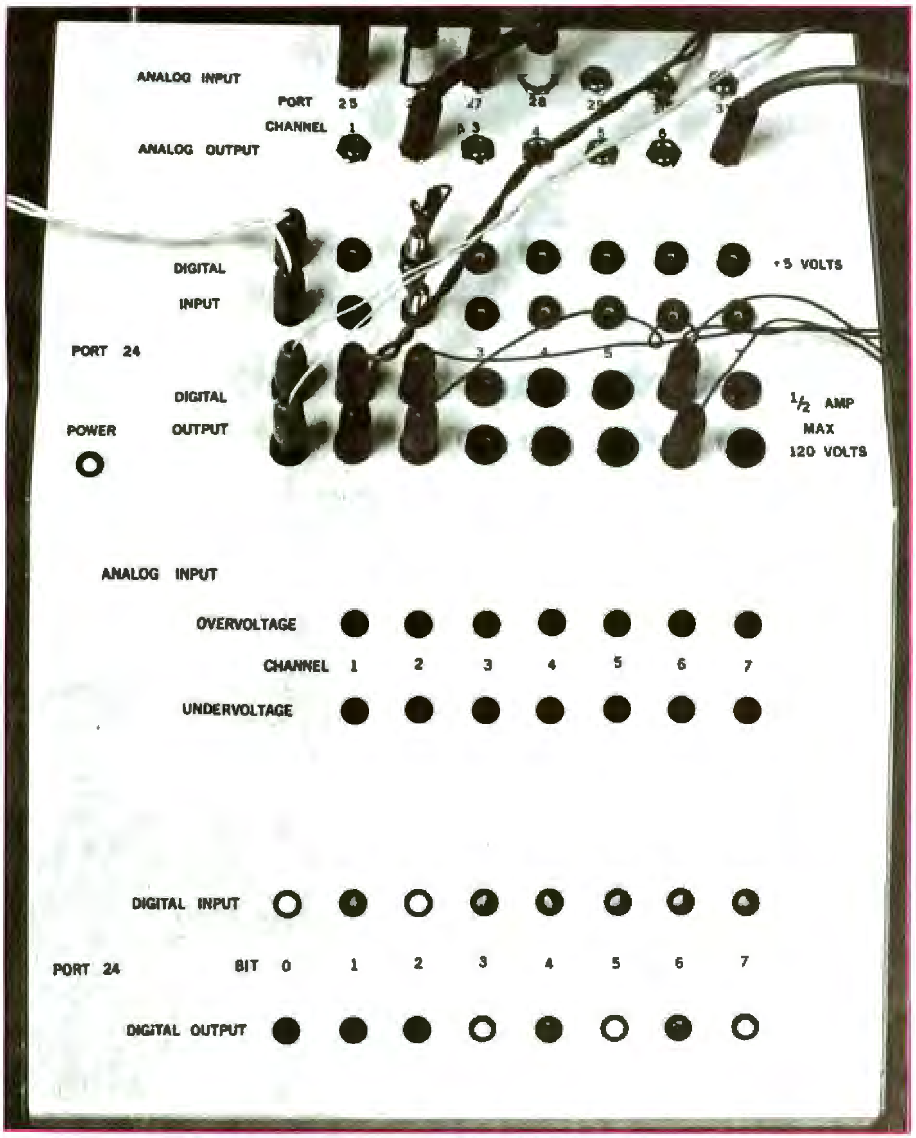

Photo 5: *Close-up of the interface box. Instruments to be sampled are plugged into the computer's analog input jacks. Voltages outside the range of the A/D converter are indicated by the overvoltage or undervoltage LEDs. A display of graphic data may be obtained by plugging an oscilloscope or a strip-chart recorder into the analog output jack. Lamps, motors, and other devices are turned on and off by the digital output relays.*

DLER, SAMPLER, and PROCESSOR. The first module keeps track of when data needs to be recorded, the second records the data, and the third saves the data on disk and calls special event programs.

The sampling routines function as follows (see the flowchart in figure 5): the real-time clock requests an interrupt, which causes a jump to the INTERRUPT HANDLER program. This is handled by the vectored priority-interrupt capability of the North Star Z80 processor. The INTERRUPT HANDLER decrements a timing counter and checks to see if it's time to sample. If not, the computer returns to the job it was working on before the interrupt. If it is time to sample, the SAMPLER routine is entered.

The SAMPLER routine reads data from each active channel of the A/D board and sums them with previous data stored in a temporary double buffer. This feature allows the program to do on-line averaging of from 1 to 256 points before storing the resulting values. For instance, if 16 points are to be averaged, SAMPLER is entered sixteen times. The first fifteen times SAMPLER adds the new samples to the old ones and returns immediately to the pre-interrupt job. On the sixteenth time, the routine does the summation of the new data with the sums of the old, changes an internal pointer to the other half of the double buffer, and enters PROCESSOR.

PROCESSOR has several functions. It performs the averaging of the data from each of the channels and stores this average value in the main buffer. When the buffer is full, it calls on subroutines that write the buffer out to disk. In addition, PROCESSOR keeps track of the time and the locations of programs that execute special events (like activating lights or pumps) at particular times. For instance, when PROCESSOR is initialized, it is loaded with the locations of these special programs and the time to execute them. When the time for a particular event elapses, PROCESSOR will call the location that controls the event. After checking the time of all events, PROCESSOR returns to the pre-interrupt location.

The use of a double buffer by SAMPLER permits data points to be summed and stored in one half of the buffer while PROCESSOR is still working on the other half of the double buffer. The only restriction of this system is that PROCESSOR must finish with its half of the double buffer before SAMPLER has collected and summed all of its data points.

Two other assembler programs, the initializers for PROCESSOR and

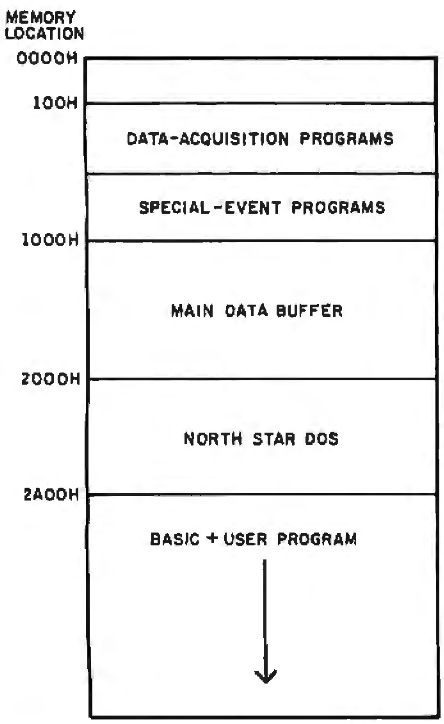

Figure 4: *Memory map that shows the hexadecimal memory locations of the machine-language acquisition programs, North Star operating system, and BASIC.*

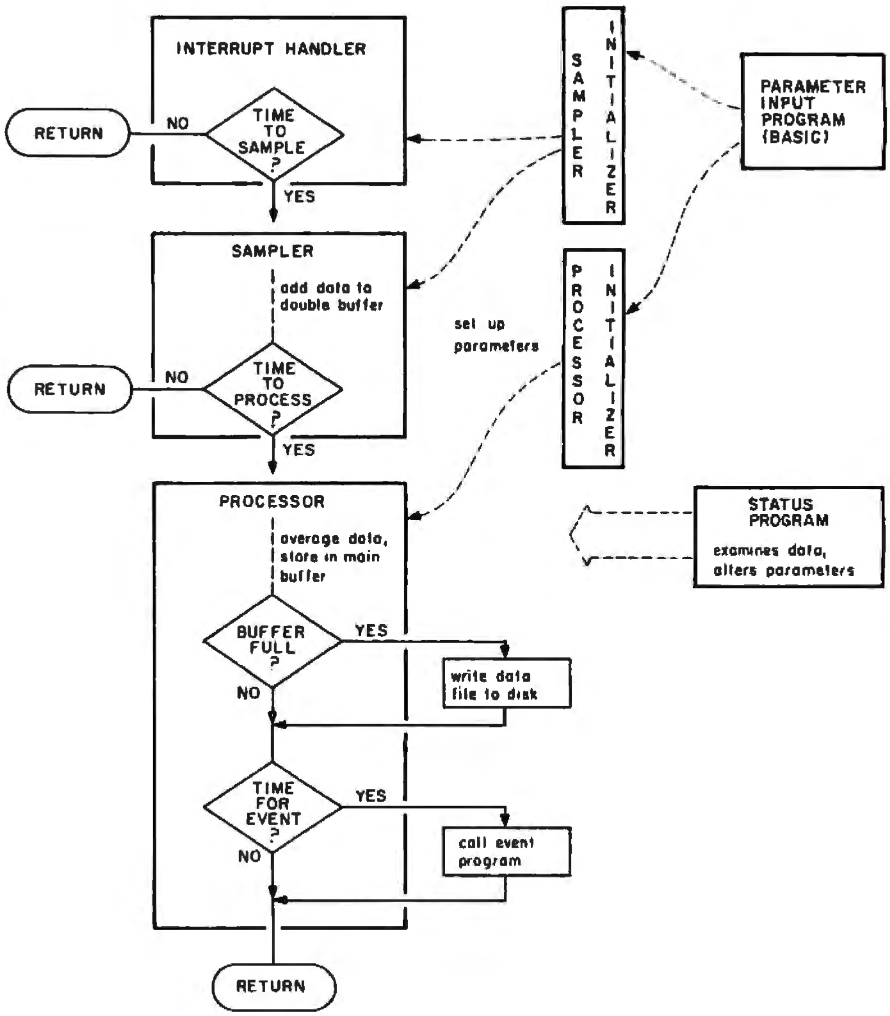

Figure 5: *Flowchart of the machine-language data-acquisition programs and their interface with BASIC.*

Listing 1: *Z80 machine-language program that contains the subroutines necessary for maintaining an interrupt-driven data-acquisition system. Among these subroutines is an interrupt-handler, a data sampler, and a data-storage and special-event processor. The design includes provisions for interfacing with BASIC programs. This version was written using a TDL (Xitan) assembler, hence the TDL Z80 mnemonics.*

```
                        ;**********************************
                        ;**                              **
                        ;**           DATAQU             **
                        ;**                              **
                        ;**********************************
                        ;
                        ;SETS UP PARAMETER LOCATIONS AND CALLS
                        ;UTILITY PROGRAMS
                        ;
                                .PABS
0100                            .LOC     100H
                        ;
                        ;
                        ;OUTPUT MESSAGE AND RETURN TO DOS.
                        ;REQUIRED FOR PROPER LOADING BY DOS.
                        ;
2028                    DOS = 2028H     ;DOS ENTRY POINT
                        ;
                        ;
0100    21 0109                 LXI     H,..MESS        ;OUTPUT MESSAGE
                                                        ;TO CONSOLE
0103    CD 047A                 CALL    MESSOUT ;
0106    C3 2028                 JMP     DOS     ;RET TO DOS
                        ;
0109    3E2044415441    ..MESS: .ASCIZ  /> DATA AQUISITION PRGM (VERS. 1
                        .2) LOADED
0132    0D0A
0134    0D0A00          /
                        ;TABLE OF CONSTANTS AND VARIABLES:
                        ;
0137                    CHNL:   .BLKB   1       ;# OF CHNLS TO SAMPLE
0138                    INT$S:  .BLKB   1       ;# INTRRPTS/SAMPLE
0139                    S$DPT:  .BLKB   1       ;# SAMPLES/DATA PT
013A                    SCNTR:  .BLKB   1       ;SAMPLE COUNTER
013B                    DIVSR:  .BLKB   1       ;PROCESSING CODE
013C                    N$EVTS: .BLKB   1       ;# PROGRAMMED EVENTS
013D                    ETIME:  .BLKW   32D     ;EVENT TIME 1 (2 BYTES)
                                                ;ADDR EVENT 1 PRGM
                                                ;...ETC.. TO EVENT
                                                ;  #N$EVTS
017D    1000            BFSTRT: .WORD   1000H   ;START ADDR MAIN BUFF
017F    1000            MBUFPT: .WORD   1000H   ;MAIN BUFFER POINTER
0181    01C8            OTMPAD: .WORD   TMPBF1  ;OLD BUFFER POINTER
0183    01E8            NTMPAD: .WORD   TMPBF2  ;NEW BUFFER POINTER
0185    202020202020    FLNAME: .ASCII /         / ;FILENAME W/BLANK
                        ;
                        ;
                        ;


                                .INSERT B:INTHDLR
                      @;******************************************
                      @;*
                      @;******************************************
                      @;*                                        *
                      @;*  INTERRUPT HANDLER & SAMPLER ROUTINE   *
                      @;*                                        *
                      @;******************************************
                      @;
                      @;THIS ROUTINE IS ENTERED BY CLOCK INTERRUPT.
                      @;IT COUNTS THE # OF INTERRUPTS SINCE THE
                      @;LAST SAMPLE WAS TAKEN.  WHEN THE INTERRUPT
                      @;COUNT = #INT/SAMPLE (AS SET UP BY "INIT")
                      @;THEN DATA IS INPUT FROM EACH OF THE ACTIVE
                      @;CHANNELS OF THE CROMEMCO D+7A I/O BOARD.
                      @;MODIFIED DATA IS SUMMED WITH PREVIOUS DATA AND
                      @;STORED BACK IN THE BUFFER.  WHEN THE BUFFER
                      @;IS FULL (IE # OF SAMPLES TAKEN EQUALS
                      @;SAMPLES/DATA PT) THEN THE BUFFER ADDR'S ARE
                      @;UPDATED AND CONTROL GOES TO THE "PROCESSOR".
                      @;
                      @;B'= INTERRUPT COUNTER
                      @;
018E    D9            @INTHLD: EXX                      ;SAVE REGS
018F    08            @        EXAF                     ;
0190    3E50          @        MVI      A,50H           ;RESET CLOCK FLAG
0192    D306          @        OUT      6
0194    05            @        DCR      B               ;TIME TO SAMPLE?
0195    2805          @        JRZ      SAMPLE          ;YES
0197    D9            @        EXX                      ;NO,RESTORE REGS
0198    08            @        EXAF                     ;
0199    FB            @        EI                       ;
019A    ED4D          @        RETI
                      @;
                      @;SAMPLER;  FOR THE FOLLOWING SECTION OF CODE
                      @;REGISTERS ARE USED AS FOLLOWS:
```

Listing 1 continued on page 93

SAMPLER, are shown in figure 5. These routines make it easy for BASIC to send the required sampling parameters to the data-acquisition program, to initialize the Z80 processor's alternate register set used by those routines, and to enable interrupts so that sampling may begin. The BASIC program communicates with these two initializers by first creating in memory a table that consists of the appropriate values of the parameters (obtained by prompting the operator). It then uses the CALL function to jump to the initializer and sends the address of the table in the DE register pair.

Once sampling has begun, a BASIC program can also follow the course of sampling, displaying the data contained in the PROCESSOR main buffer, altering some of the sampling parameters, stopping sampling, or terminating the experiment (which causes the data in the buffer to be saved on disk).

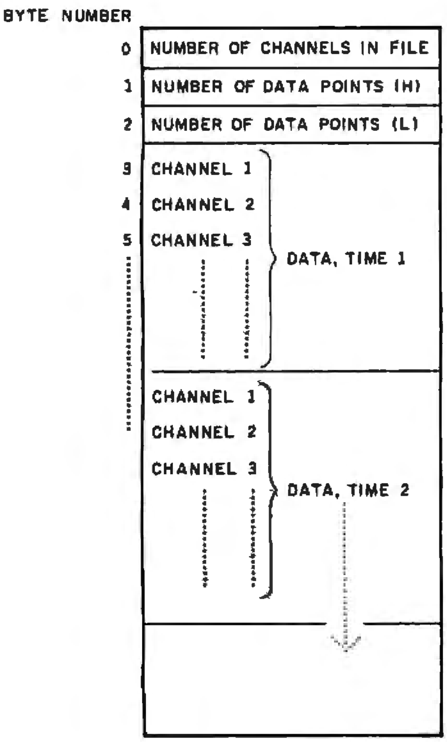

Figure 6: *Map of the structure of the data file used by the author's programs. Three file-information bytes precede the actual data in the file.*

Data File Structure

When the main data buffer is full or the sampling period is finished, three file-information bytes are placed in front of the buffer and it is written directly to disk using the North Star DOS library routines. The resulting disk-file structure is shown in figure 6. The first byte indicates how many channels (in binary encoding) are sampled in the file. The next two bytes indicate the total number of data points (in bytes) in the file (again, binary encoded, high byte followed by low byte). Each of the following bytes is a data point, represented in two's-complement notation, which is the form of the data returned by the Cromemco A/D board. If the number of channels in a file record is N, then the data for channel 1 will be found at every Nth byte, beginning at the fourth byte; similarly for channel 2, which begins at the fifth byte, and so on for all N channels.

There are two ways for a BASIC program to access the data in the file. North Star BASIC has a byte-access facility, so the data may be read a byte at a time by a READ statement. Alternatively, the data may be written from disk to memory, and then the EXAM (or PEEK, as it is called in some BASICs) function can read the data. I use this latter method: it reduces disk accesses and permits the graphic display on the oscilloscope to be done by fast machine-language routines.

Once the data is read into BASIC, almost any kind of manipulation can be done. As an example, curve A in figure 1 shows the raw data of the growth response of a sunflower seedling to a short pulse of light. Curve B shows the same data after smoothing (using a 9-point moving weighted average), and curve C shows the output of a program that fits the data to a first-order exponential decay to a lower asymptote.

Other Uses

I've discussed how the computer has been used in the laboratory for data acquisition, experiment control, and data processing, and up to this point the controller aspects of the computer have been fairly rudimentary. Primarily, it has been functioning as a timer to turn devices on and off.

The next level of complexity involves having the computer examine the data as it comes in, and exert its control options contingent upon what the data look like. For example, a BASIC program could study the data contained in the main data buffer. When it detects a certain pattern, say an oscillation or the peak of an oscillation, it could then turn on a lamp or apply a voltage to electrodes; the only limit to the complexity of the controlling features is in the program itself.

In addition to these uses, the microcomputer can assist the researcher in other ways. Small- to medium-sized mathematical modeling programs can be run on these machines. A bibliography program could help the researcher keep notes in useful, accessible order. A text editor can be used to write articles. Finally, for those jobs that require a larger computer, the microcomputer can collect the primary data, then transmit the data at high speed to the mainframe computer. ■

1. Balcom, Orv. "Interfacing a Microcomputer to the Analog World." *Interface Age*, July 1978, pages 68-75.
2. Olson, Hank. "Controlling the Real World." March 1978 BYTE, pages 174-177.
3. Titus, J; P Rony; C Titus; D Larsen. *Microcomputer-Analog Converter Software and Hardware Interfacing*. Indianapolis: Howard W Sams & Co Inc, 1978.

Readers may obtain the programs and complete source listings as shown in this article at a nominal copying fee from the North Star Software Exchange, North Star Computer Co, Berkeley CA 94710.

Listing 1 continued:

```
                            @;
                            @;          A<=INPUT DATA
                            @;          B<=CHANNEL COUNTER
                            @;          C<=I/O PORT ADDR
                            @;         DE<=DATA W/SIGN BIT COMPLEMENTED
                            @;         HL<=PREVIOUS BUFFER DATA
                            @;          X<=ADDR OF BUFFER DATA (ADRDAT)
                            @;
019C    DDE5                @SAMPLE: PUSH    X        ;SAVE REG
019E    DD2A 0183           @        LIXD    NTMPAD   ;LOAD BUFFER ADDR
01A2    0E19                @        MVI     C,31Q    ;CHANNEL ADDR=31 OCT
01A4    3A 0137             @        LDA     CHNL     ;#CHANNELS
01A7    47                  @        MOV     B,A      ;INTO B
01A8    1600                @        MVI     D,0      ;CLEAR
                            @;
                            @;
01AA    DD22 01B3           @FETCH:  SIXD    ADRDAT+1 ;STORE ADDR
01AE    DD22 01BC           @        SIXD    STDAT+1  ;
01B2    2A 0000             @ADRDAT: LHLD    0000     ;GET DATA WHOSE ADDR IS
                            @                         ;STORED HERE(0 NOT REAL
                            @                         ;ADDRESS)
01B5    ED78                @        INP     A        ;
01B7    EE80                @        XRI     128D     ;COMPL SIGN BIT
01B9    5F                  @        MOV     E,A      ;
01BA    19                  @        DAD     D        ;ADD TO OLD DATA
01BB    22 0000             @STDAT:  SHLD    0000     ;STORE DATA AT ADDR
                            @                         ;STORED HERE (0 NOT
                            @                         ;REAL ADDR)
01BE    05                  @        DCR     B        ;ALL CHNLS SAMPLED?
01BF    2847                @        JRZ     COUNT    ;YES
01C1    DD23                @        INX     X        ;NO,UPDATE BUF ADDR
01C3    DD23                @        INX     X        ;
01C5    0C                  @        INR     C        ;UPDATE PORT ADDR
01C6    18E2                @        JMPR    FETCH    ;LOOP TILL DONE
                            @;
                            @;
01C8                        @TMPBF1: .BLKW   16D      ;BUFFER 1
01E8                        @TMPBF2: .BLKW   16D      ;BUFFER 2
                            @;
                            @;
                            @;DATA IS NOW LOADED AND STORED IN TEMP BUF
                            @;
0208    DDE1                @COUNT:  POP     X        ;RESTORE X
020A    3A 0138             @        LDA     INT$S    ;REINITIALIZE
020D    47                  @        MOV     B,A      ;INTRPT CNTR
020E    3A 013A             @        LDA     SCNTR    ;TIME TO PROCESS?
0211    3D                  @        DCR     A        ;
0212    280E                @        JRZ     UPDATE   ;YES,DO PROCESS
0214    32 013A             @        STA     SCNTR    ;NO,STORE SAMPLE CNTR
0217    DB06                @        IN      6        ;CHECK CLOCK FLAG
0219    CB57                @        BIT     2,A      ;
021B    202B                @        JRNZ    CLK2FS   ;CLOCK TOO FAST
021D    D9                  @        EXX              ;OK,RESTORE REGS
021E    08                  @        EXAF             ;
021F    FB                  @        EI               ;ENABLE INTERRUPTS
0220    ED4D                @        RETI             ;RETURN
                            @;
                            @;
                            @;THIS SECTION ENTERED WHEN TEMP BUFFER
                            @;IS FILLED.  IT UPDATES TEMP BUFFER ADDRS
                            @;AND SAMPLE COUNTER.
                            @;
0222    2A 0183             @UPDATE: LHLD    NTMPAD   ;SWITCH BUF ADDRS
0225    ED5B 0181           @        LDED    OTMPAD   ;
0229    22 0181             @        SHLD    OTMPAD   ;
022C    ED53 0183           @        SDED    NTMPAD   ;
0230    3A 0139             @        LDA     S$DPT    ;INITIALIZE SAMPLE
0233    32 013A             @        STA     SCNTR    ;  COUNTER
0236    3EFF                @        MVI     A,255    ;SET OVERFLOW FL
0238    32 0247             @        STA     OVFLAG   ;
023B    DB06                @        IN      6        ;CHK CLOCK FLAG
023D    CB57                @        BIT     2,A      ;
023F    2007                @        JRNZ    CLK2FS   ;CLOCK TOO FAST
0241    D9                  @        EXX              ;OK,RESTORE REG
0242    08                  @        EXAF             ;
0243    FB                  @        EI               ;ENABLE INTRPTS
0244    C3 02DD             @        JMP     PROCSR   ;GOTO PROCESSOR
                            @;
0247                        @OVFLAG: .BLKB   1        ;OVERFLOW FLAG
                            @;
                            @;
                            @;****************************************
                            @;
                            @;CLOCK TO FAST; STOP SAMPLING; CUE
                            @;OPERATOR AND RET
                            @;
0248    F3                  @CLK2FS: DI               ;DISABLE INTRPTS
0249    21 0250             @        LXI     H,..MESS;OUTPUT MESSAGE
024C    CD 047A             @        CALL    MESSOUT ;
024F    C9                  @        RET
                            @;
```

Listing 1 continued on page 94

Listing 1 continued:

```
0250               @..MESS: .ASCIZ  /
0250   0D0A2A2A2A2A@*****************************************
027C   0D0A        @
027E   0D0A53414D50@SAMPLING ABORTED: INTERRUPT RATE TOO FAST!
02AA   0D0A        @
02AC   0D0A2A2A2A2A@*****************************************
02D8   0D0A        @
02DA   0D0A00      @/
                   @;        .INSERT B:PROCSR
                   @;*****************************************
                   @;*                                       *
                   @;*              PROCESSOR                *
                   @;*                                       *
                   @;*****************************************
                   @;
                   @;THIS ROUTINE TAKES DATA FROM THE OLD TEMP
                   @;BUFFER OF "INTHDLR", CALLS "FNXN" TO PROCESS
                   @;IT, AND TRANSFERS THE PROCESSED DATA TO MAIN
                   @;BUFFER STORAGE.  IT KEEPS TRACK OF TIME
                   @;(BY # DATA PTS) AND CALLS SPECIAL EVENT
                   @;PROGRAMS AT THE APPROPRIATE TIMES.  WHEN
                   @;MAIN BUFFER FILLS UP, IT CALLS "DATWR"
                   @;TO WRITE THE DATA OUT TO DISK.
                   @;ALL REGISTERS ARE PRESERVED.  ANY USER
                   @;PROGRAM CALLED BY PROCSR MUST PRESERVE
                   @;THE IX AND IY REGISTERS, AS WELL AS ANY
                   @;OTHERS SPECIFIED AT THE CALLING POINT.
                   @;
02DD   ED73 035B   @PROCSR: SSPD    STKPT   ;STORE OLD STACK PNTR
02E1   31 0100     @        LXI     SP,100H ;LOAD NEW SP
02E4   F5          @        PUSH    PSW     ;SAVE REGISTERS
02E5   C5          @        PUSH    B       ;
02E6   D5          @        PUSH    D       ;
02E7   E5          @        PUSH    H       ;
02E8   21 0247     @        LXI     H,OVFLAG;CLEAR OVERFLOW FLAG
02EB   34          @        INR     M       ;
                   @;
                   @;SET UP REGISTERS FOR TRANSFER:
                   @;       ;
                   @;
                   @;       DE<=MAIN BUFFER POINTER
                   @;       BC<=# OF CHANNELS
                   @;       HL<=OLD TEMP BUFFER POINTER
                   @;        A<=PROCESSOR CODE
                   @;
02EC   ED5B 017F   @        LDED    MBUFPT  ;
02F0   0600        @        MVI     B,0     ;
02F2   21 0137     @        LXI     H,CHNL  ;
02F5   4E          @        MOV     C,M
02F6   2A 0181     @        LHLD    OTMPAD  ;FETCH OTMPAD
02F9   3A 013B     @NEXT:   LDA     DIVSR   ;
02FC   CD 041F     @        CALL    FNXN    ;DO # CRUNCHING
                   @                        ;DE, HL MUST BE SAVED
                   @                        ;ON RET, (HL) SHOULD
                   @                        ;CONTAIN THE DATA PT.
                   @                        ;HIGH BYTE OF DATA PT
                   @                        ;SHOULD BE 00 ON RET
                   @;
02FF   3E7F        @TRANSF: MVI     A,127D  ;CHECK OVERFLOW
0301   BE          @        CMP     M       ;
0302   CC 035D     @        CZ      BEEP    ;
0305   3E80        @        MVI     A,128D  ;CHECK UNDERFLOW
0307   BE          @        CMP     M       ;
0308   CC 035D     @        CZ      BEEP    ;
030B   EDA0        @        LDI             ;DO TRANSFER
030D   2B          @        DCX     H       ;
030E   3E00        @        MVI     A,0     ;CLEAR ACC
0310   77          @        MOV     M,A     ;CLEAR BUFFER
0311   23          @        INX     H       ;
0312   23          @        INX     H       ;
0313   EA 02F9     @        JO      NEXT    ;TILL DONE
                   @;
                   @;
0316   ED53 017F   @        SDED    MBUFPT  ;STORE MAIN BUF PNTR
031A   21 E000     @        LXI     H,-2000H;MAIN BUFFER FULL?
031D   19          @        DAD     D       ;SUBTRACT 8K
                   @                        ;MAIN BUFFER GOES
                   @                        ;FROM 1000H TO 2000H
031E   3A 0137     @        LDA     CHNL    ;ADD # CHANNELS
0321   C602        @        ADI     2       ;ADD TERMINATION BYTES
0323   0600        @        MVI     B,0     ;
0325   4F          @        MOV     C,A     ;
0326   ED4A        @        DADC    B       ;
0328   F4 0487     @        CP      DATWR   ;YES, WRITE OUT DATA
032B   FB          @        EI              ;ENABLE INTERRUPTS
                   @;
                   @;
                   @;CHECK IF TIME FOR PROGRAMMED EVENTS:
                   @;
032C   3A 013C     @        LDA     N$EVTS  ;LOAD A W/# EVENTS
032F   B7          @        ORA     A       ;=0?
```

Listing 1 continued:

```
0330    CA 034B    @          JZ       ..OUT     ;YES, OUT & RET
0333    47         @          MOV      B,A       ;B<=#EVENTS
0334    21 013E    @          LXI      H,ETIME+1;LOAD LOC OF LOW
                   @                             ;BYTE OF TIME
                   @;
                   @;
0337    3EFF       @..LOOP:   MVI      A,-1      ;SUBTRACT 1 FROM TIME
0339    86         @          ADD      M         ;
033A    77         @          MOV      M,A       ;
033B    D4 0366    @          CNC      HYDCR     ;NO CARRY: DECREMENT
                   @                             ;HIGH BYTE, RETURN WITH
                   @                             ;Z=0
033E    CC 0362    @          CZ       ENDCK     ;CHECK HIGH BYTE
                   @                             ;RET W/Z=1 IF 00
0341    CC 036B    @          CZ       ESTART    ;TIME FOR EVENT?
                   @                             ;HL MUST
                   @                             ;BE SAVED BY PRGMS.
0344    23         @          INX      H         ;INCREMENT POINTER TO
0345    23         @          INX      H         ;NEXT EVENT TIMER
0346    23         @          INX      H         ;   (LOW BYTE)
0347    23         @          INX      H         ;
0348    05         @          DCR      B         ;
0349    20EC       @          JRNZ     ..LOOP    ;LOOP TILL ALL EVENT
                   @                             ;TIMERS ARE PROCESSED
                   @;
                   @;
                   @;
034B    3A 0247    @..OUT:    LDA      OVFLAG    ;CHECK OVERFLOW FLAG
034E    B7         @          ORA      A         ;SET Z FLAG
034F    C4 0372    @          CNZ      OVFLOW           ;  OOH-OOH !!
0352    E1         @RSTORE:   POP      H         ;RESTORE REGS
0353    D1         @          POP      D         ;
0354    C1         @          POP      B         ;
0355    F1         @          POP      PSW       ;
0356    ED7B 035B  @          LSPD     STKPT     ;RESTORE OLD SP
035A    C9         @          RET                ;OK,RET TO STATUS
035B               @STKPT:    .BLKW    1         ;STORE OLD SP HERE
                   @;
                   @;*******************************************
                   @;
035D    3E07       @BEEP:     MVI      A,7       ;OUTPUT BELL TO CRT
035F    D302       @          OUT      2         ;
0361    C9         @          RET                ;
                   @;
                   @;
                   @;
                   @;*****************************************
                   @;
                   @;ENDCK :  CHECKS THE HIGH BYTE OF A 16-BIT
                   @;WORD.  RETURNS WITH Z FLAG SET IF THE HIGH
                   @;BYTE = 0.  EXPECTS HL TO CONTAIN THE ADDR
                   @;OF THE LOW BYTE (WITH HIGH BYTE IN (HL-1).
                   @;REG A SHOULD EQUAL 00 ON ENTERING.
                   @;ALL REGS ARE PRESERVED.
                   @;
0362    2B         @ENDCK:    DCX      H         ;
0363    BE         @          CMP      M         ;
0364    23         @          INX      H         ;
0365    C9         @          RET                ;
                   @;
                   @;
                   @;
                   @;*****************************************
                   @;
                   @;HYDCR: THIS SR SUBTRACTS ONE FROM  HIGH BYTE
                   @;OF A 16-BIT WORD.  EXPECTS HL TO POINT TO THE
                   @;LOW BYTE, WITH HIGH BYTE AT (HL-1).  ALL REGS
                   @;ARE PRESERVED. ON RETURN  Z FLAG SET TO 1 AND
                   @;CARRY CLEARED.
                   @;ASSUMES  REG A NOT 00 ON ENTERING.
                   @;
0366    2B         @HYDCR:    DCX      H         ;DCR HIGH BYTE
0367    35         @          DCR      M         ;
0368    23         @          INX      H         ;RESTORE HL
0369    B7         @          ORA      A         ;SET Z=1
036A    C9         @          RET                ;
                   @;
                   @;
                   @;
                   @;******************************************
                   @;
                   @;ESTART: SAVES REG HL ON STACK AND THEN JUMPS
                   @;TO PRGM.  THE USER PRGM SHOULD PRESERVE IX
                   @;AND IY REGS AND RETURN TO THE "PROCESSOR"
                   @;BY <POP H    ;    RET   >
                   @;
036B    E5         @ESTART:   PUSH     H         ;SAVE REGS
036C    23         @          INX      H         ;GET LOW BYTE ADDR
036D    5E         @          MOV      E,M       ;LOAD JMP ADDR
036E    23         @          INX      H         ;INTO DE
036F    56         @          MOV      D,M       ;
```

Listing 1 continued on page 416


TELEPHONE

Data-Base Management Systems: Powerful Newcomers to Microcomputers

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Large computers are already running many successful applications programs developed by using commercial data-base management system (DBMS) packages. DBMS packages for large computers sell in the $50,000 to $200,000 range and require approximately 50 K words of memory. As a result, it is impractical to apply the development concepts used on large machines to data-base management systems for the microcomputer. A more promising approach is to create a DBMS offering the best features of systems for larger computers, yet fitting the microcomputer's capabilities. Two of the authors of this article, Gary Koehler and Mike Gagle, work for Micro Data Base Systems, Inc, and have participated in the development of a data-base management system tailored to the microcomputer. Called MDBS.DMS, this data-base management package serves as the basis of most of the discussion that follows. But first we'll explain the basic concepts and terms of data-base management systems.

Data-Base Concepts and Terms

The central concept of data-base management is to create files that can be linked from different points of view. By using different linkages, the user can generate different kinds of reports based on the same data files. The DBMS makes this possible by handling all the details of data storage. When using the DBMS, the user never refers to physical storage locations, but deals instead with the conceptual structure of the data.

Many of the concepts used in commercial data-base systems were defined by CODASYL (Conference on Data Systems Languages). A brief description of important concepts from the CODASYL report of April 1971 will help you follow the rest of this article:

Data item: A unit of data that can take on a range of values. Examples of data items are customer names, part numbers, and selling prices. Each data item may have a name assigned to it.

Record type: A collection of zero or more data items. An example of a record type is the collection of the data items customer name, address, city, and zip code. The user can give a record type a name (such as CUSTOMER, for our example). A data-base record corresponds to a logical record in programming languages such as Pascal.

Record occurrence: A record type such as CUSTOMER can have many occurrences in the data base, one occurrence for each customer. The values of the data items in each record occurrence reflect the appropriate values for the corresponding customer.

Set-type: As data items can be grouped into records, records can be linked into sets. Sets in the CODASYL sense do not correspond to mathematical sets, but rather to an ordered grouping of related records. Usually, a set consists of one record occurrence (referred to as an OWNER) that has several occurrences of some other record type (MEMBERS) associated with it. Consider again the case in which a supplier could supply various parts. A set relation could be defined between the supplier record type and the parts record type linking a supplier with different parts supplied.

In the CODASYL specifications, sets are said to be "one-to-many" sets. Any member record occurrence (such as a part) can be associated with only one owner

← Circle 22 on inquiry card.

record occurrence (such as a supplier) through a given set-type. If several suppliers can supply the same part, there exists between supplier and part a "many-to-many" relationship. Some DBMS (such as MDBS.DMS) explicitly allow many-to-many relationships, while others can support such relationships only by creating a dummy record, called a "nub" or "link" record.

Features of Data-Base Systems

Data-base management systems offer many attractive features, including: multiple views of data, data-base flexibility, nonredundancy of data, security of data, self-description of data bases, query processing, and interfacing with a host language.

Sequential file organization is adequate for some programming purposes. Sequential files assume that all data in a file will be processed in a certain order. The ISAM (indexed sequential-access method) helps meet the need to access a particular sequential record by reference to an index or key.

For simple data structures, an ISAM-type organization works well enough. But as the interrelationships of the data become more complex, even simple reports and routine updating of data require more file handling. Furthermore, simple data structures quickly become complex as users begin to appreciate the usefulness of the computer and request more applications.

A true data-base management system is specifically designed to handle complex data structures by offering multiple views of the same data; that is, a DBMS lets an applications programmer view a data structure in the way most convenient for the application at hand. Greater convenience means that the programmer spends much less time writing, debugging, and maintaining programs—enough time to offset the start-up costs of the DBMS.

Data-Base Flexibility

It's common to hear someone say, "Now that we have our inventory system computerized, it sure would be nice to have a report on ______." The blank can be filled with almost anything from "delivery times from all suppliers in Kansas" to "average inventory level of parts that cost more than $10 each." Sometimes hindsight shows you should have included in the system some data (say a reorder point) not defined in the original data base. That's why DBMS should include the ability to add or delete types of data in the data base. Of course, changing the data-base structure often requires updating the data occurrences. If the DBMS can do this updating, the process of changing the data structure is straightforward.

In the absence of a restructuring feature, the typical user defines extra item fields for "future use" or else rebuilds the data base. The first alternative is wasteful and doesn't allow for adding or deleting record types or set relationships. The second alternative is painful to say the least.

Nonredundancy of Data

Often, one piece of information (say a supplier's name) appears in several different data files. If the supplier incorporates and changes its name, updating requires finding the old name in *each* of the data files and then making the change in each case. Further, if a file is sorted by names, the file may have to be re-sorted.

If the name of the supplier occurs only in *one* place, updating is simple. And so it is in a data base with an appropriately organized structure. The data-base system automatically performs any data reorganization necessary to maintain sorted orders. The nonredundancy feature also reduces problems caused by inconsistent data.

Security of Data

There are a variety of ways to protect the privacy and integrity of data in a data base. These include sophisticated authorization checks and password validation. The security mechanisms of the MDBS.DMS data-base management system will serve as an example.

When the user defines data to the MDBS.DMS system, the user gives each piece of information separate read- and write-access levels. Additionally, the system provides that each user may be declared and given unique read- and write-access permission and an access password. When the data base is used, the DBMS prohibits persons from reading or writing data unless their access level permits it. A clerk may be restricted to reading the

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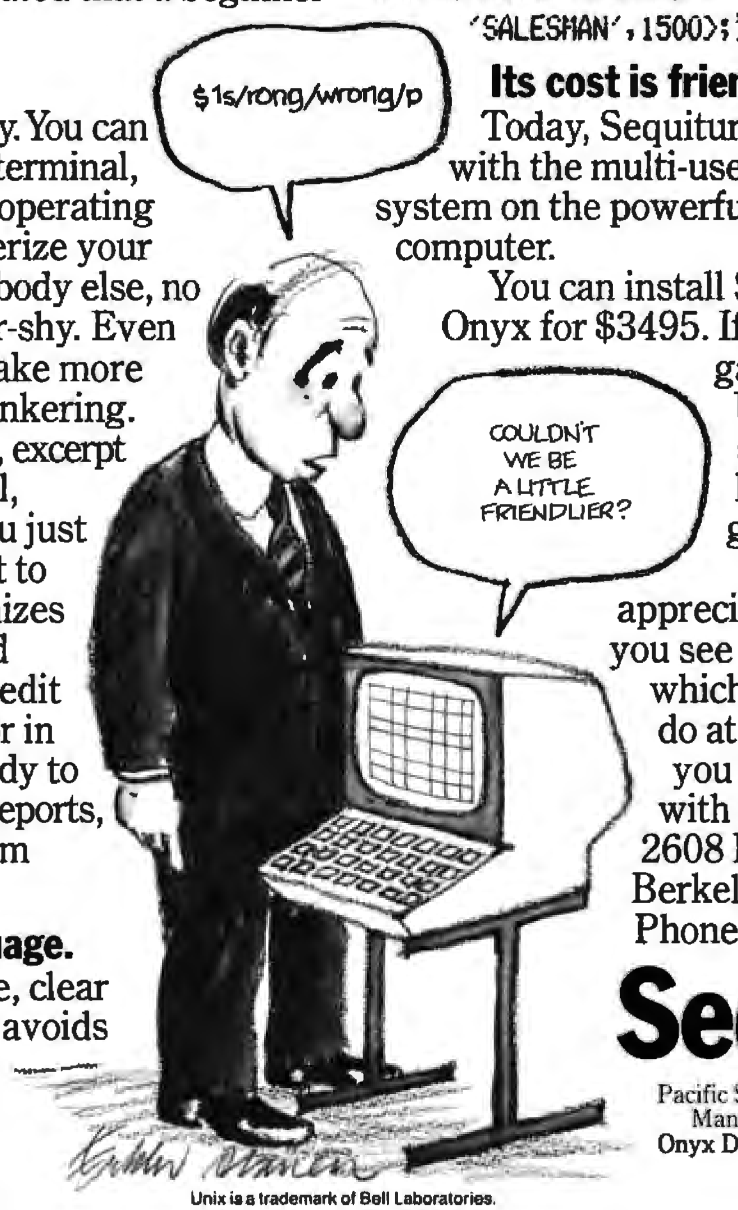

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price of an item, while a manager can change the price. The system also includes precautions that make it difficult to *infer* information about data in the system.

Self-Description of Data Bases

An integral part of a data base is its *data directory*, which contains information about each type of data defined in the data base. This information includes the name of the data item, the data type (in the larger sense, eg: CHARACTER, REAL, INTEGER), the length of the data item, and its read/write access levels. Data items are grouped into named records, and records may be organized by sets. Thus, the data directory keeps information on the records (including the data items in the record and the read/write access levels of the record itself), and the sets (including the ordering of the set of records and the records allowed in the set).

The data directory contains all the information needed for the DBMS to maintain the data base. However, the presence of the data directory implies that generalized programs can be developed that are independent of any particular data base. These programs can extract information from the data directory and, based on this information, process the data in the data base. There are essentially two types of programs: a broad class written in a host language such as BASIC, and a generalized report writer or query processor.

Query Processing

A query system consists of programs that can add, retrieve, update, and display data from a data base. A query system is flexible in that it is not restricted to a particular data base or data structure, but will work with a wide variety of data bases. Query systems are usually intended for nonspecialists who wish to use a data base or programmers who wish to perform initial checkouts of program logic. Most query systems can be used to generate reports from data in the data base, and the more sophisticated query systems allow great flexibility in use.

Examples of query language statements might be:

- LIST CUSTOMER NAME, ADDRESS FOR STATE = 'OHIO'
- CHANGE UNIT-PRICE TO 0.75 FOR PART.NUMBER = 056127

Interface with a Host Language

Most data-base systems can be accessed by "host-language" programs. In microcomputers, this is generally done by a call to a subroutine that contains the DBMS code, which is written in machine language for optimal processing speed. Typical capabilities include:

- Create: Create an occurrence of a data record.
- Store: Store data in the data base.
- Fetch: Retrieve data from the data base.
- Insert: Put a data record in a data relationship.
- Modify: Change data in a data record.

- Find: Locate a data occurrence.
- Delete: Delete a data record.
- Remove: Remove a data record from a set.

The data base may also be accessed by query systems, as mentioned previously.

Program Example

In order to explain the advantages of using a DBMS in a microcomputer environment, we will present an example using the fictitious Nibble Computer Store. This store retails components and equipment supplied by many vendors. One of the store's major concerns is to keep customers satisfied by providing speedy service. The store maintains an inventory-order system with a tracking of customer orders.

Handling this management problem requires the following reports:

Report 1: A list of customers (sorted by name) who have placed an order within the last sixty days.
Report 2: A list of parts that need to be reordered.
Report 3: A list of customers whose orders have been outstanding for more than two days. Also, a list of the parts (and the name of the suppliers of those parts) that are holding up those orders.

The data requirements are as follows:

Requirement 1: Maintain a list of customers, sorted by name *and* by customer number.
Requirement 2: Maintain a list of suppliers, sorted by name *and* by supplier number.
Requirement 3: Maintain a list of parts stocked, sorted by description *and* by part number.
Requirement 4: Keep track of which parts are supplied by each manufacturer.
Requirement 5: Keep track of the status of each customer's orders.

We first show a possible (although simplistic) way to implement such a system using conventional file-management techniques.

A Conventional Approach

Although there are many ways to design a system to perform the functions needed by the Nibble Computer Store, most suitable systems would require creating and maintaining a file for each particular application. Table 1 shows several types of files that might be required.

A look at the five data requirements shows why so many files are needed. Consider requirement 1. A file of customer data can be sorted either by name or number. But to sort the file by both name and number usually requires that a copy of the file be made first. Then the original file can be sorted by customer name, and the

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File 1	File 2	File 3
(Sorted by Customer Name)	(Sorted by Customer Number)	(Sorted by Supplier Name)
Customer Name	Customer Name	Supplier Name
Customer Number	Customer Number	Supplier Number
Street	Street	Street
City	City	City
State	State	State
Zip Code	Zip Code	Zip Code

File 4	File 5	File 6
(Sorted by Supplier Number)	(Sorted by Part Number)	(Sorted by Part Description)
Supplier Name	Part Number	Part Number
Supplier Number	Part Description	Part Description
Street	Selling Price	Selling Price
City	Quantity in Inventory	Quantity in Inventory
State	Reorder Point	Reorder Point
Zip Code		

File 7	File 8	File 9
(Sorted by Part Number)	(Sorted by Date Received)	(Sorted by Order Number)
Part Number	Order Number	Order Number
Supplier Number	Customer Number	Part Number
	Date Received	Quantity Ordered
	Date Shipped	

Table 1: *The types of files needed to handle the data-processing tasks of the Nibble Computer Store without using a data-base management system. Since different tasks require different views of the data, the programmer must maintain files sorted appropriately for each task.*

copy file by customer number. So data requirement 1 gives us files 1 and 2.

The same problem of double sorts applies to data requirements 2 (suppliers) and 3 (parts). This gives us six files.

The easiest way to keep track of which parts are supplied by which supplier (data requirement 4) is to define a file containing the part numbers for each supplier (file 7).

Data requirement 5 is to keep track of each customer's orders. Several approaches are possible, but we'll handle the task by creating an order file (file 8).

Turning now to the required reports, report 1 is a list of customers who have placed an order in the last sixty days. The report can be made by scanning file 8 (orders sorted by date) for orders falling in the sixty-day period, and then writing the corresponding customer numbers on a file. That file can then be sorted and used to extract the names of customers from file 1. Then the names extracted can be listed in still another file.

A list of parts to be reordered (report 2) is trickier. The parts-on-order file (file 9) can be scanned, and then the quantity ordered for unfilled orders can be written on a scratch file. This file can then be sorted on the part number, and the quantity on order can be summed for each part. This quantity can then be compared to the number of parts in inventory and the reorder points (file 5) to show which parts must be reordered.

The conventional approach could generate report 3 in two phases. First, the orders sorted by date (file 8) can be scanned to find orders that have been outstanding for more than two days. The customer numbers can then be written on a file, sorted, and used to extract the customers' names from file 1. A similar process will find the parts whose order quantity is larger than the quantity on hand, giving the suppliers' names.

Four other files would also be required. Files 3 and 4 maintain supplier information (with two different sort orders). File 6 maintains parts information and file 7 gives the correspondence between suppliers and parts.

Obviously, writing the needed programs and maintaining these data files would be tedious, even though this is a *simple* example, with other complicating factors left out. If additional requirements are placed on the system (such as a listing of suppliers that supply parts that sell for less than $2), more programs have to be written. We also have a problem with redundant data—if a customer's address changes, we have to update two files. Even worse, if a customer's *name* changes, one of the files has to be completely re-sorted.

The primary problem here is that different applications require different "views" of the data. For some applications, having the order information embedded in the customer file would be best. But for other applications, the order data might need to be closely limited to the supplier file. The result is that the compromise solution of figure 1 is developed, with corresponding programming complexity.

The Data-Base Management System Approach

Figure 1 shows a data structure that could be used to represent the information needed for the inventory-order

system. The boxes represent record types (corresponding to customers, suppliers, parts, orders, and order quantities). The names within boxes correspond to *data* items, the basic units of data that form the records. Finally, four *set-types* are defined. Sets are used to associate records. For example, SET3 is used to associate parts with their suppliers. Since, in our simple system, each part is supplied by only one supplier, we say that the supplier "owns" parts, in accordance with the data-base terminology of *set owners* and *members*. Figure 2 shows two suppliers and the parts they supply.

Information in a data base is accessed by "traversing set occurrences." To find out what parts Acme Computer supplies, we look at the occurrence of SET3, which has Acme Computer as an owner, and examine each member of the set. This allows us to retrieve data about each part supplied by Acme.

Since sets are used to access data-base information, it follows that some sets must be defined that allow the user to "get his foot in the door" of the data base. This is done with sets having a record named "SYSTEM" as their owner. Such sets can be defined so all occurrences of a record can be accessed by traversing a system-owned set.

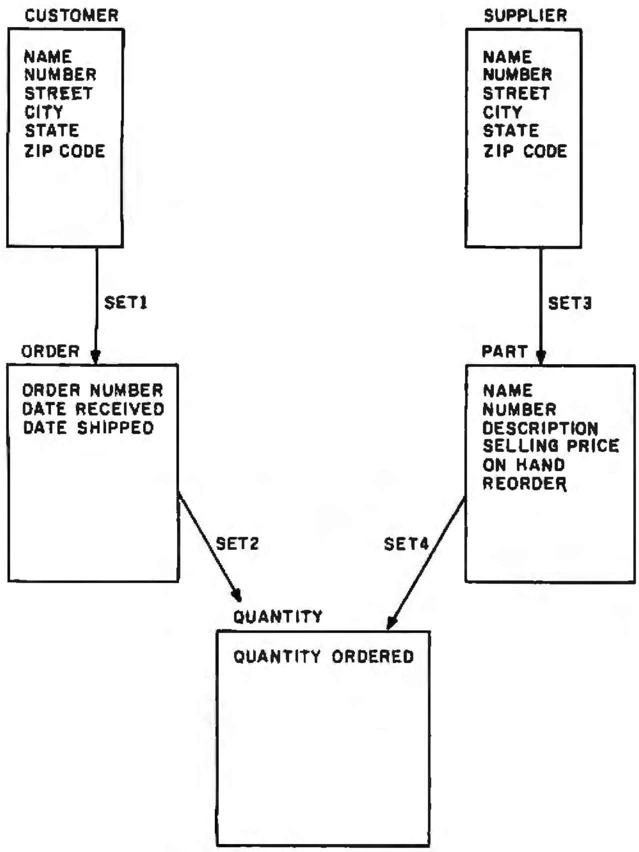

Figure 1: *A data structure representing the information needed to handle the data-processing tasks of the Nibble Computer Store. The boxes represent record types. The names within boxes correspond to the data items that make up the records. The lines between boxes represent set-types—ordered groupings of related records. SET3, for example, associates parts with their suppliers.*

One more thing about sets: since the members of a set occurrence are accessed one at a time as we traverse the set, we can put an ordering on the set. We can define the set to be ordered on, say, Supplier Name, and the DBMS will automatically maintain the records in the set in sorted order. If we define a different set ordered on Supplier Number, we can access the records in either order simply by choosing the appropriate set. Additional set orderings, such as FIFO (first in, first out) or LIFO (last in, first out), are also supported.

With this background, we can discuss the structure of figure 1. Each customer can have zero, one, or more orders in our system, and SET1 is defined with CUSTOMER as owner and ORDER as member. The relationship between orders and parts is less clear. Each order is made up of one or more parts, but each part can appear in more than one order. Also, the problem arises of where to put the quantity ordered of each part. If we put the quantity in the ORDER record, we don't know which part the quantity refers to (since the order can consist of more than one part). Similarly, an ambiguity exists if the quantity is kept in the PARTS record. The solution is to define a QUANTITY record. By appropriate use of SET2 and SET4, the quantity of each part for each order can be determined.

The data structure of figure 1 as described in MDBS.DDL, a Data Definition Language of Micro Data Base Systems, Inc, is as shown in listing 1 (see page 110). The data definition for our example is relatively straightforward. The sets such as CUSTNAME and CUSTNUM allow us to access the customer records sorted by either name or number.

Several points should be made about the DDL description in listing 1. Five users have been defined, one for each functional area of the company. The first user name, STOCKROOM, is followed by read and write authorization levels and the user's password (317-54-7674). A user may process data that has an access level equal to or less than his own. For example, the stockroom user can read supplier information, but isn't allowed to alter it since the stockroom has a write-access level of 10, while all supplier information has a write-access level of 50. The access levels were defined by:

Level 1: Stockroom/Inventory Control—This department must be able to read part numbers, part descriptions, quantity on hand, and reorder point for inventory control purposes. It must also be able to read supplier information for reorder purposes, determine quantity ordered for each part, and update quantity on hand of each part as it is put into inventory.

Level 2: Shipping—This department must be able to read parts information, customer names and addresses, and order information. It must also be able to update shipping date and quantity on hand for each part shipped.

Level 3: Order Processing—This department must be able to enter new orders.

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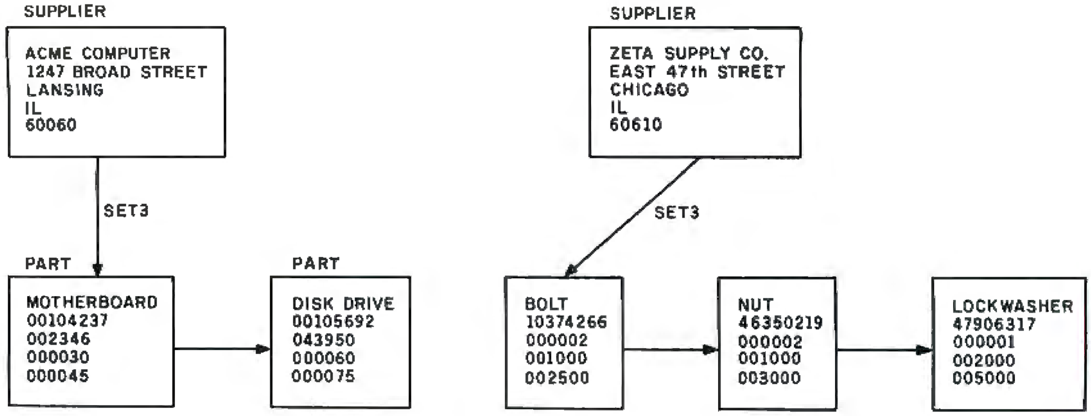

Figure 2: *Two of the Nibble Computer Store's suppliers and the parts they supply. This figure gives more detail on SET3 of figure 1.*

Level 4: New Accounts—This department must be able to add new customers to the customer list and update customer information.

Level 5: Purchasing—This department must be able to add new supplies to supplier list and update supplier information. It must also be able to define new parts and alter prices of parts and the supplier-parts relationships.

We are now ready to generate the reports listed in table 1. To simplify matters, we will not be concerned with loading data into the data bases or updating information. Out of the repertoire of DML (Data Management Language) commands in MDBS.DMS, we will use:

FFM: Find First Member—Insures that the first record in a set occurrence is available for processing.

FNM: Find Next Member—This command actually traverses the set occurrence, moving from one record to the next each time it is called.

SOM: Set Owner based on Member—Indicates that the record that is the "current" member of one set should be treated as the owner of some other set.

SMM: Set Member based on Member—Indicates that the "current" member of one set-type is also the current member of some other set.

GFM: Get Field from Member—Retrieves data from a named field (item) in the "current" member of a set.

In MDBS.DMS, all routines return a value that gives a status indication. Frequently, a nonzero status value represents an error condition. MDBS.DMS can be called from several languages running under CP/M and from disk-based Radio Shack, Apple, and North Star systems. The status value is returned to a user-defined variable. For example, in modified North Star BASIC (see reference 1), a call to FFM looks like:

E0 = CALL (*addr*, "FFM, SET3")

Here, *addr* is the address of the MDBS.DMS software. Two entry points to MDBS.DMS are required: one for defining blocks and one for the DMS routines.

The BASIC user of MDBS.DMS can define named data blocks (similar to the sub-schema of the CODASYL committee report). For example, the user may want to define a block called PARTDATA made up of the BASIC variables:

N	for part number
D$	for part description
P	for price
O	for on-hand quantity
R	for reorder point

So to insert data into the data base, the user issues the call:

E0 = CALL (*addr*, "CRS, PART, PARTDATA")

Text continued on page 120


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Listing 1: *A description in MDBS.DDL (Data Definition Language) of a data structure meeting the needs of the fictitious Nibble Computer Store. This description corresponds to the data structure shown in figure 1.*

```
PASSWORDS
       STOCKROOM                10  10   317-54-7674
       SHIPPING                 20  20   SECRET
       ORDER PROCESSING         30  30   MAILROOM
       NEW ACCOUNTS             20  40   IGLOO
       PURCHASING               30  50   317-742-7388

RECORD CUSTOMER                 20  30
ITEM   CNAME     CHAR   30      20  40
ITEM   CNUMBER   BIN     2      20  40
ITEM   STREET    CHAR   20      20  40
ITEM   CITY      CHAR   20      20  40
ITEM   STATE     CHAR    2      20  40
ITEM   ZIP       CHAR    5      20  40

RECORD SUPPLIER                 10  50
ITEM   SNAME     CHAR   30      10  50
ITEM   SNUMBER   BIN     2      10  50
ITEM   STREET    CHAR   20      10  50
ITEM   CITY      CHAR   20      10  50
ITEM   STATE     CHAR    2      10  50
ITEM   ZIP       CHAR    5      10  50

RECORD PART                     10  10
ITEM   PNUMBER   BIN     2      10  50
ITEM   DESCR     CHAR   20      10  50
ITEM   PRICE     REAL    8      30  50
ITEM   ONHAND    BIN     2      10  10
ITEM   REORDER   BIN     2      10  50

RECORD ORDER                    20  20
ITEM   ONUMBER   BIN     2      20  30
ITEM   RECEIVED  BIN     2      20  30
ITEM   SHIPPED   BIN     2      20  20

RECORD QUANTITY                 10  30
ITEM   QORDERED  BIN     2      10  30

SET    SET1      MAN   1:N      20  30
                                  SORTED    ONUMBER
OWNER  CUSTOMER
MEMBER ORDER

SET    SET2      MAN   1:N      20  30
                                  FIFO
OWNER  ORDER
MEMBER QUANTITY

SET    SET3      MAN   1:N      10  50
                                  SORTED    PNUMBER
OWNER  SUPPLIER
MEMBER PART
```

Listing 1 continued on page 112

Listing 1 continued:

```
SET     SET4     MAN  1:N  10  30
                               IMMAT
OWNER   PART
MEMBER QUANTITY

SET     CUSTNAME AUTO 1:N  20  40
                               SORTED   CNAME
OWNER   SYSTEM
MEMBER CUSTOMER

SET     CUSTNUM  AUTO 1:N  20  40
                               SORTED   CNUMBER
OWNER   SYSTEM
MEMBER CUSTOMER

SET     SUPLNAME AUTO 1:N  10  50
                               SORTED   SNAME
OWNER   SYSTEM
MEMBER SUPPLIER

SET     SUPLNUM  AUTO 1:N  10  50
                               SORTED   SNUMBER
OWNER   SYSTEM
MEMBER SUPPLIER

SET     PARTDESC AUTO 1:N  10  50
                               SORTED   DESCR
OWNER   SYSTEM
MEMBER PART

SET     PARTNUM  AUTO 1:N  10  50
                               SORTED   PNUMBER
OWNER   SYSTEM
MEMBER PART

SET     ORDERS   AUTO 1:N  20  30
                               SORTED   RECEIVED
OWNER   SYSTEM
MEMBER ORDER
```

Listing 2: *A program segment opening a data base using the data-base system MDBS.DMS. Brackets are used to pass addresses of variables; the right bracket has been translated to a parenthesis by North Star BASIC. Lines 1390 through 1470 represent portions of the program not given here.*

```
1000 REM *************************************************************
1010 REM **
1020 REM ** User's name and password **
1030      DIM N$(16) , P$(12)
1040 REM **
1050 REM ** Input user's name **
1060      INPUT "NAME? " , N$
1070      PRINT
1080 REM **
1090 REM ** Now the password -- but no echo **
```

Listing 2 continued on page 114

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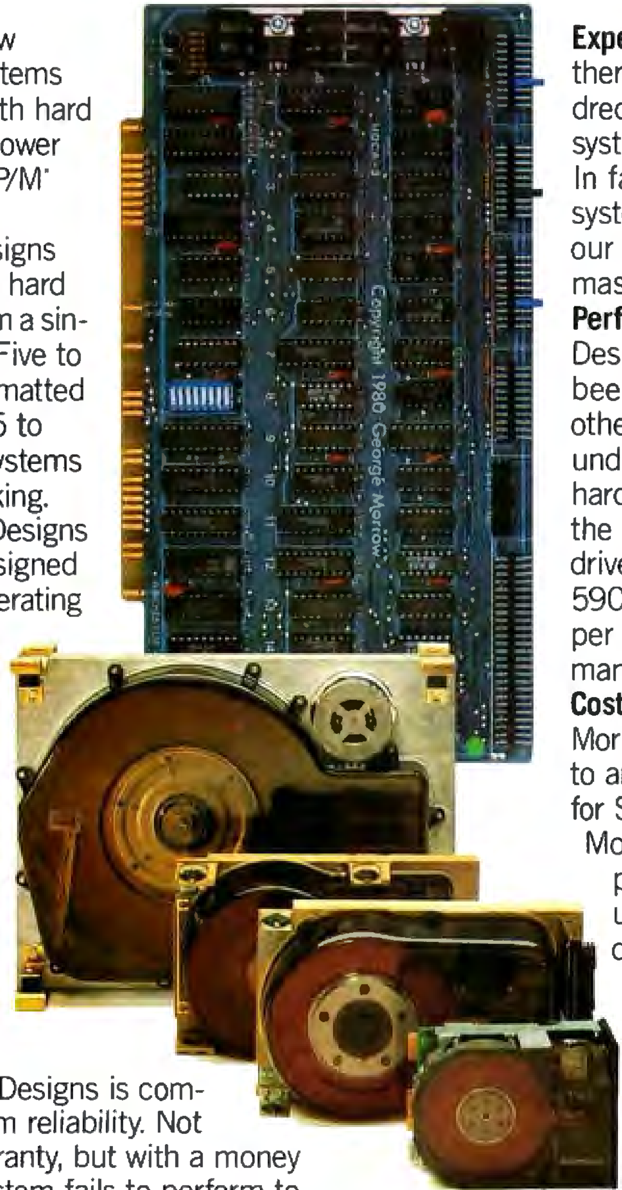

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Listing 2 continued:

```
1100        PRINT "PASSWORD"
1110        T$ = INCHAR$ (0)
1120        IF ASC ( T$ ) = 13 THEN 1190
1130        P$ (1,1) = T$
1140        FOR J = 1 TO 15
1150        T$ = INCHAR$ (0)
1160        IF ASC ( T$ ) = 13 THEN 1190
1170        P$ = P$ (1,J) + T$
1180        NEXT J
1190        PRINT T$
1200 REM **
1210 REM ** Filename **
1220        F$ = "NIBBLE"
1230 REM **
1240 REM ** Allow the user to modify the data base **
1250        R$ = "MODIFY"
1260 REM **
1270 REM ** MDBS.DMS routines **
1280        A1 = 32768
1290        A2 = A1 + 3
1300 REM **
1310 REM ** Define a data block **
1320        E0 = CALL (A2, "DEFINE,OPENLIST" ,[F$),[N$),[P$),[R$),4)
1330        IF E0 <> 0 THEN 1450
1340 REM **
1350 REM ** Open the data base **
1360        E0 = CALL ( A1 ,    " OPEN , OPENLIST "  )
1370        IF E0 <> 0 THEN 1450
1380 REM **
1390 REM **************************************************************
1400 REM **
1410 REM ** ** APPLICATION PROGRAM **
1420 REM **
1430 REM **************************************************************
1440 REM **
1450 REM ** ** ERROR PROCESSING **
1460 REM **
1470 REM **************************************************************
```

Listing 3: *A BASIC program segment generating a list of customers who have placed orders at the Nibble Computer Store in the last sixty days. This listing assumes that an MDBS.DMS data base has been opened and that data blocks have been defined.*

```
1000 REM ** The following code assumes that variable D0 **
1010 REM ** has been initialized to the current Julian date **
1020 REM **
1030 REM ** MDBS.DMS addresses **
1040        A0 = 32768
1050        A1 = A0 + 3
1060 REM ** Data Block Definitions **
1070        E0 = CALL (A1,"DEFINE,RECVD",[D1),1)
1080        E0 = CALL (A1,"DEFINE,CNAME",[C$),1)
1090 REM ** Access each customer in turn **
1100        E0 = CALL (A0,"FFM,CUSTNAME")
1110        IF E0 <> 0 THEN 1350
1120 REM ** Check each of this customer's orders **
1130        E0 = CALL (A0,"SOM,SET1,CUSTNAME")
```

Listing 3 continued on page 116

Phenomenal!

STAR-EDIT FOR CP/M

From Supersoft, a phenomenon in screen editors/word processors. Star-Edit is a completely tested, "no surprises" screen editor suitable for any text processing task, including program writing and word processing. Its features compare with the highly acclaimed "EMACS" editor. Even though Star-Edit is at least as powerful as any other screen editor, it can be learned easily and quickly by both programmers and non-programmers. Star-Edit includes:

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- Ability to enter ANY typeable character into the file
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Someone familiar with an ordinary typewriter should have no trouble learning and using Star-Edit. The novice need learn only a few commands to make immediate use of the editor; the experienced user will find that Star-Edit has a complete set of text manipulation commands (nearly one hundred).

Requires: 32K CP/M system with cursor-addressable terminal

Star-Edit: $225.00
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Listing 3 continued:

```
1140        E0 = CALL (A0,"FFM,SET1")
1150        IF E0 <> 0 THEN 1310
1160 REM ** Retrieve date order was received **
1170 REM ** Variable D1 receives the date **
1180        E0 = CALL (A0,"GFM,SET1,RECVD")
1190 REM ** Following statement assumes that D0 and D1 are
1200 REM ** Julian dates **
1210        IF D0-D1 <= 60 THEN 1280
1220 REM ** Order is over 60 days old -- check next order **
1230        E0 = CALL (A0,"FNM,SET1")
1240        GOTO 1150
1250 REM ** Customer has placed order within last 60 days **
1260 REM ** Print customer's name **
1270 REM ** Variable C$ receives the customer name **
1280        E0 = CALL (A0,"GFM,CUSTNAME,CNAME")
1290        PRINT C$
1300 REM ** Process next customer **
1310        E0 = CALL (A0,"FNM,CUSTNAME")
1320        IF E0 = 0 THEN 1130
1330 REM ** All customers processed **
1340        E0 = CALL (A0,"CLOSE")
1350        STOP
```

Listing 4: *A BASIC program segment that determines which parts the Nibble Computer Store needs to reorder. The listing assumes that an MDBS.DMS data base has been opened and that data blocks have been defined.*

```
1000 REM ** MDBS.DMS addresses **
1010        A0 = 32768
1020        A1 = A0 + 3
1030 REM ** Data Block Definitions **
1040        E0 = CALL (A1,"DEFINE,SHIPPED",[D2),1)
1050        E0 = CALL (A1,"DEFINE,QORDERED",[N1),1)
1060        E0 = CALL (A1,"DEFINE,ONHAND",[Q1),1)
1070        E0 = CALL (A1,"DEFINE,REORDER",[Q2),1)
1080        E0 = CALL (A1,"DEFINE,PNUMBER",[P0),1)
1090        E0 = CALL (A1,"DEFINE,PNAME",[P$),1)
1100 REM ** Generate the list in part-number order **
1110        E0 = CALL (A0,"FFM,PARTNUM")
1120 REM ** Initialize to sum the quantity ordered **
1130        N=0
1140        E0 = CALL (A0,"SOM,SET4,PARTNUM")
1150        E0 = CALL (A0,"FFM,SET4")
1160 REM ** This part may not have any orders outstanding **
1170 REM ** If this is the case, E0 will be set non-zero **
1180        IF E0 <> 0 THEN 1400
1190 REM ** Locate the order corresponding to this quantity **
1200 REM ** Ignore the order if it has been filled **
1210        E0 = CALL (A0,"SMM,SET2,SET4")
1220 REM ** If a non-zero shipping date is present, the order
1230 REM ** has been filled (Shipping date is returned in D2) **
1240        E0 = CALL (A0,"GFO,SET2,SHIPPED")
1250        IF D2 <> 0 THEN 1310
1260 REM ** Order is pending -- Sum the quantity ordered **
1270 REM ** Variable N1 receives the quantity ordered **
1280        E0 = CALL (A0,"GFM,SET4,QORDERED")
1290        N = N + N1
```

Listing 4 continued on page 118

SuperSoft's Optimizing

for CP/M

The SuperSoft "C" compiler supports most of version 7 Unix standard "C". Several special and widely desired features are supported, including:

- Macro expansions via the **#define** statement.
- Include files using the **#include** statement.
- Inline assembly code is supported with the **#asm** and **#endasm**.
- The object code may be ROMed.
- Programs may be ORGed for any location.
- Completely **dynamic memory allocation** is supported, both by the compiler and in user programs. (That is, the functions 'alloc' and 'free' are provided with the compiler.)

SuperSoft "C" is a two pass compiler. The first pass of the compiler produces an intermediate code (U-code, for Universal code). Pass two contains both the translator and the optimizer. The intermediate code is optimized and assembly code is output to file.

The optimizer typically results in 40% code reduction. This means that compiled object code will run nearly as fast as that which was written in assembler.

An important feature of the compiler is that assembly code is produced. This means that "hand optimization" of critical sections is possible. Also, the inline coder allows easy insertion of assembly language routines.

With the compiler comes the complete source code to the I/O libraries. These libraries are equal to or better than any that exist for the 8080/Z80 computer system. Functions included:

open	close	read	write
seek	tell	fopen	create
putc	getc	flush	

The Seek command supports absolute, relative from front, and relative from end of file. Fopen includes fcreat. Also included with the compiler are numerous sample programs and a complete library of useful functions.

Compile time options include listing file, console output, syntax checking and others.

Requires: 48K CP/M, (more recommended)

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Listing 4 continued:

```
1300 REM ** Process the next order for this part **
1310      E0 = CALL (A0,"FNM,SET4")
1320      IF E0 <> 0 THEN 1210
1330 REM **
1340 REM ** Pending order quantities have been determined **
1350 REM ** Check to see if quantity on hand less quantity
1360 REM ** ordered is less than the reorder point
1370 REM **
1380 REM ** Variable Q1 receives the quantity on hand **
1390 REM ** Variable Q2 receives the reorder point **
1400      E0 = CALL(A0,"GFM,PARTNUM,ONHAND")
1410      E0 = CALL (A0,"GFM,PARTNUM,REORDER")
1420      IF Q1-N > Q2 THEN 1490
1430 REM ** Part needs to be reordered **
1440 REM ** Retrieve part name (P$) and part number (P0) **
1450      E0 = CALL (A0,"GFM,PARTNUM,PNUMBER")
1460      E0 = CALL (A0,"GFM,PARTNUM,PNAME")
1470      PRINT "REORDER PART#",P0,P$
1480 REM ** Process next part **
1490      E0 = CALL (A0,"FNM,PARTNUM")
1500      IF E0 = 0 THEN 1130
1510      E0 = CALL (A0, CLOSE")
1520      STOP
```

Listing 5: *A BASIC program segment that produces a report on overdue orders placed at the Nibble Computer Store. The listing assumes that an MDBS.DMS data base has been opened and that data blocks have been defined.*

```
1000 REM ** MDBS.DMS addresses **
1010      A0 = 32768
1020      A1 = A0 + 3
1030 REM ** Data Block Definitions **
1040      E0 = CALL (A1,"DEFINE,SHIPPED",[D1),1)
1050      E0 = CALL (A1,"DEFINE,RECVD",[D2),1)
1060      E0 = CALL (A1,"DEFINE,ONUMBER",[O1),1)
1070      E0 = CALL (A1,"DEFINE,CNAME",[C$),1)
1080      E0 = CALL (A1,"DEFINE,CNUMBER",[C0),1)
1090      E0 = CALL (A1,"DEFINE,QORDERED",[Q1),1)
1100      E0 = CALL (A1,"DEFINE,ONHAND",[N1),1)
1110      E0 = CALL (A1,"DEFINE,PNUMBER",[P0),1)
1120      E0 = CALL (A1,"DEFINE,SNAME",[S$),1)
1130 REM ** Find an order which has been outstanding for more
1140 REM ** than two days **
1150      E0 = CALL (A0,"FFM,ORDERS")
1160      IF E0 <> 0 THEN 1560
1170      E0 = CALL (A0,"GFM,ORDERS,SHIPPED")
1180 REM ** Ignore orders which have already been shipped **
1190      IF D2 <> 0 THEN 1530
1200 REM ** Check to see if this order is over two days old **
1210      E0 = CALL (A0,"GFM,ORDERS,RECVD")
1220      IF D0-D1 <= 2 THEN 1530
1230 REM ** An 'old' order has been found **
1240 REM ** Print customer name, customer number and order number
1250 REM ** Variable O1 receives the order number **
1260      E0 = CALL (A0,"GFM,ORDERS,ONUMBER")
1270 REM ** Locate customer data -- number (C0) and name (C$)
1280      E0 = CALL (A0,"SMM,SET1,ORDERS")
```

Listing 5 continued on page 120

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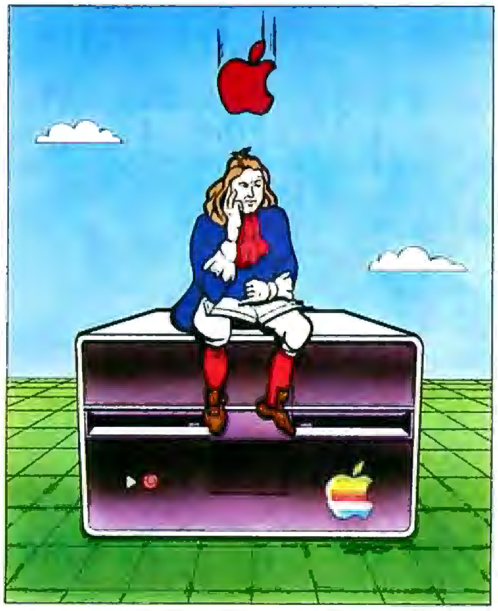

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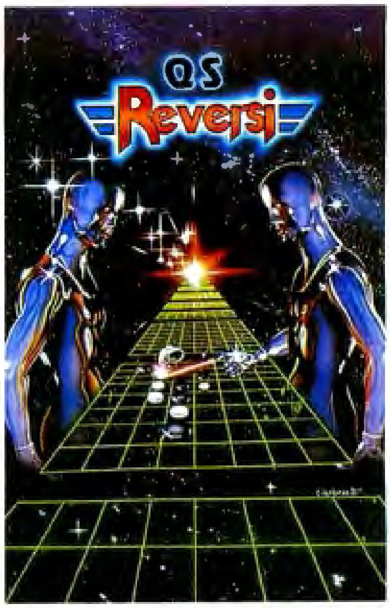

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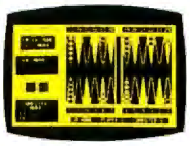

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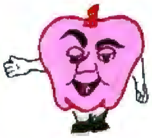

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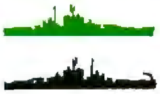

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Listing 5 continued:

```
1290        E0 = CALL (A0,"GFM,SET1,CNAME")
1300        E0 = CALL (A0,"GFM,SET1,CNUMBER")
1310        PRINT "*****",C0,C$," ORDER ",O1
1320 REM ** Determine which part(s) are holding up this order **
1330 REM **
1340 REM ** Find parts with order quantity (Q1) which exceeds **
1350 REM ** the inventory quantity (N1) for that part **
1360        E0 = CALL (A0,"SOM,SET2,ORDERS")
1370        E0 = CALL (A0,"FFM,SET2")
1380        IF E0 <> 0 THEN 1530
1390        E0 = CALL (A0,"GFM,SET2,QORDERED")
1400        E0 = CALL (A0,"SMM,SET4,SET2")
1410        E0 = CALL (A0,"GFO,SET4,ONHAND")
1420        IF N1 >= Q1 THEN 1500
1430 REM ** Offending part found **
1440 REM ** Print part number (P0) and supplier name (S$)
1450        E0 = CALL (A0,"GFO,SET4,PNUMBER")
1460        E0 = CALL (A0,"SMO,SET3,SET4")
1470        E0 = CALL (A0,"GFO,SET3,SNAME")
1480        PRINT "       PART#",P0," SUPPLIER ",S$
1490 REM ** Check next part on order (it may be overdue also) **
1500        E0 = CALL (A0,"FNM,SET2")
1510        IF E0 = 0 THEN 1390
1520 REM ** Process next order **
1530        E0 = CALL (A0,"FNM,ORDERS")
1540        IF E0 = 0 THEN 1170
1550        E0 = CALL (A0,"CLOSE")
1560        STOP
```

Text continued from page 108:
where CRS means create a record occurrence and store data into it. This call will take the data located in the variables N, D$, P, O, and R, and store them in the data base. Retrieving data from the data base is carried out in a similar way. A BASIC variable may be used in several defined data blocks.

To open a data base using MDBS.DMS, the user can give the sequence shown in listing 2. Here, the user's name and password (read in without echoing to the console) are first entered, a call to the OPEN routine of the DMS is issued, and an error check is made. (In listing 2, the brackets are used to pass addresses of variables and the right bracket has been translated to a right parenthesis by North Star BASIC.)

Listings 3, 4, and 5 are sample programs for producing the reports discussed earlier. Each of the sample program segments assumes that the data base has been opened and that data blocks have been defined.

The program in listing 3 generates a list of customers (sorted by name) who have placed an order in the last sixty days. In line 1100, the first member of set CUSTNAME (which corresponds to the customer with the lexicographically first name) is located. The error response E0 is checked for the improbable case of no customers in

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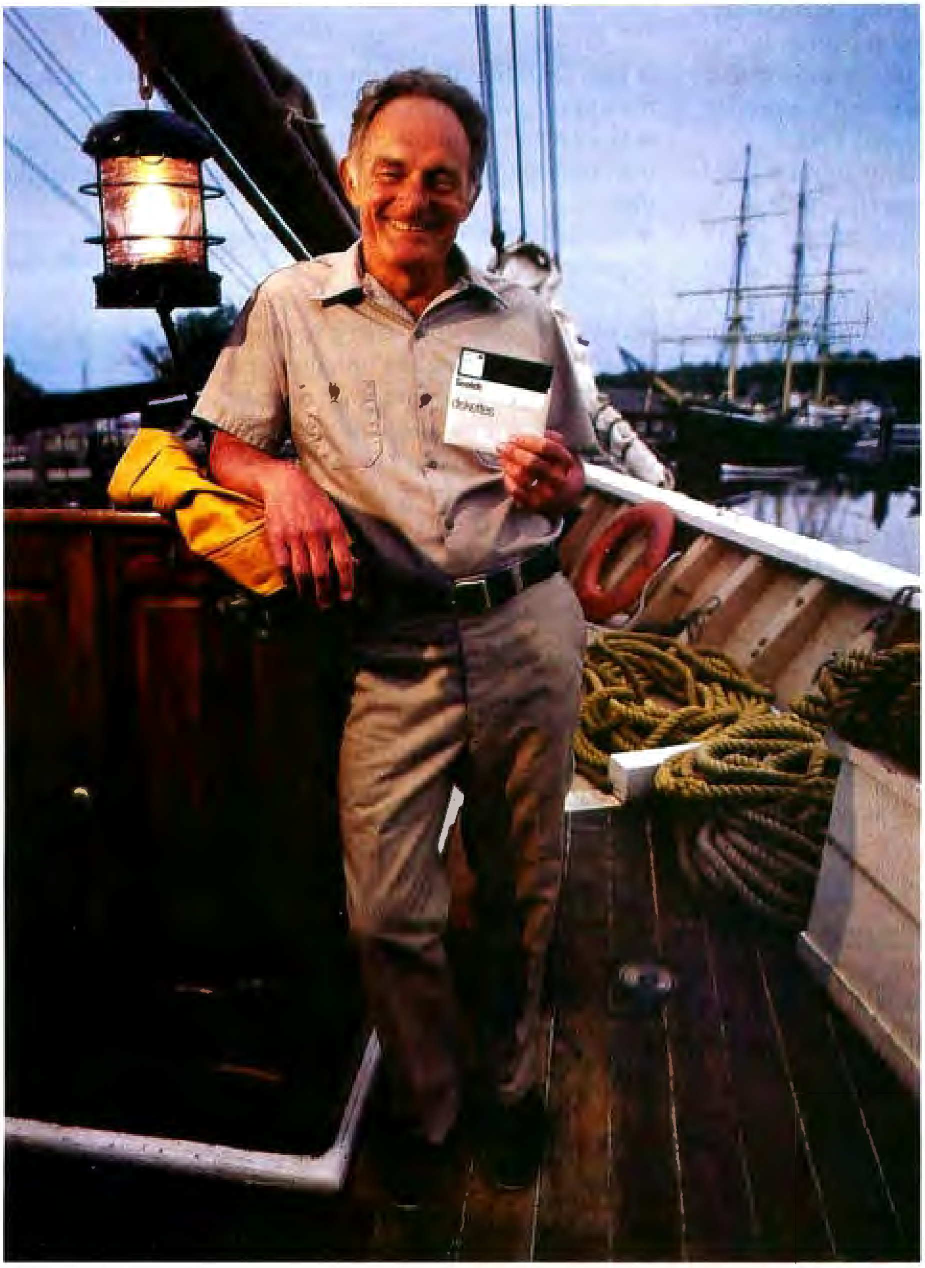

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the data base. Statements 1130 and 1140 locate the set of orders on file for the customer. The data is checked and, if the date of an order is within sixty days of the current date, the customer name is printed (statements 1280 and 1290). Statement 1310 accesses the next customer and, if we haven't reached the last customer (E0 is set nonzero when the FNM command detects end of set), the process is repeated.

A program that determines the parts that need to be reordered is shown in listing 4. A part is a candidate for reordering if the quantity in inventory less the quantity required for unfilled orders is less than some reorder point. The reorder point varies from part to part and is stored in the data base (as item REORDER in record PART).

Statement 1110 locates the first part to be processed (parts are processed in part-number order). The logic in statements 1180 through 1320 accesses the quantity ordered of the part (via SET4) for each unfilled order in the system. The inventory quantity (ONHAND) is obtained from the data base and the quantity on order for the part is used to calculate the adjusted inventory level (Q1-N). If this quantity is less than or equal to the reorder point (Q2), the number and name of the part are printed by statements 1450 through 1470. This process is repeated for all parts.

Finally, a program that produces a report on overdue orders is shown in listing 5. All orders in the system are accessed through the set named ORDERS (statements 1150 through 1160). Any order that has been shipped (indicated by a nonzero shipping date) is excluded from the report. In line 1220, the date the order was received (D1) is subtracted from the current date, and if the difference is less than three days, the order is not overdue. If the order is overdue, the customer's name and number and the order number are printed. For each part in the order, the quantity ordered (Q1) is found via set SET2 and the quantity on hand (N1) is obtained via set SET4. If the quantity ordered is greater than the quantity on hand, the part number and the number of the part's supplier are printed.

Leading data-processing experts think data-base management systems will be the ultimate software tool of the 1980s. The appeal of these systems is certain to grow as software costs become a greater and greater part of total computer costs. Data-base software can significantly reduce the costs of software development in several ways:

- The DBMS relieves the programmer of the task of maintaining data files.
- The DBMS maintains an internal data directory, keeping descriptions of data and relationships among the data.
- The DBMS lets the programmer access data in a form appropriate to each program, rather than forcing the programmer to write a program that fits the data.
- The data-base approach provides great flexibility and economy in altering the initial system to meet new needs. Since the programmer can restructure the data base, creating new files and new links to old files, the DBMS permits major system modifications with little effort and cost. Also, the programmer can generate new reports by simply adding a new program. ■

References

1. Allen Ashley (395 Sierra Madre Villa, Pasadena CA, (213) 793-5748) has developed a patch to North Star BASIC that enables a machine-language call involving multiple parameters. Ashley's patch is available with his HDS (Hybrid Development System) package for North Star BASIC (which is part BASIC and part assembly language) or from Micro Data Base Systems with its North Star BASIC interface to MDBS.DMS.
2. Haseman, W D and A B Whinston. *Introduction to Data Management*. Homewood IL: Richard D Irwin, 1977.
3. Martin, J. *Computer Data-Base Organization*. Englewood Cliffs NJ: Prentice-Hall, 1975.

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The Exatron Stringy Floppy Data-Storage System

Keith Carlson
43 McDill Rd
Bedford MA 01730

More powerful than an 8-inch Winchester? Not likely. Faster than a speeding floppy? Sometimes. Able to read huge data bases in fleeting seconds? Impossible!

Exatron's Stringy Floppy data-storage system may not compare with Superman, but from the minute I plugged my new Stringy Floppy drive into my Radio Shack TRS-80 Model I Level II computer, I was convinced it was super. It appears to be a convenient and economical way to equip a TRS-80 Model I with most of the speed and convenience of a disk drive at less than half the price. There are some problems with it, but they are minor compared to problems of audio-cassette storage.

Why Digital Cassette?

Exatron was the first company to apply the concept of a completely digital cassette-tape data-storage system to microcomputers in a practical way. Audio cassettes are simply not designed for digital recording. They are made to accommodate a limited analog frequency range: those frequencies audible to the human ear (sometimes less, depending on the quality of the tape). Also, the tape moves comparatively slowly past the write/read (record/playback) head. Finally, you have to rewind the tape to read what has been written or to write something else.

Photo 1: *The Exatron Stringy Floppy digital cassette-tape drive.*

In contrast, the Exatron digital cassettes, or *wafers*, are designed for digital recording. The tape is about 1/16 inch wide, and it is a closed loop moving in a single direction. It works in a manner similar to that of an eight-track audio tape cartridge. The tape is pulled out of the middle of the single reel and is wound up around the outside. No rewinding is necessary because the tape forms one big loop. The tape runs past the read/write head fast enough to transfer data at 7200 bps (bits per second). The wafers are about the height and width of a business card and about 3/8 inch thick.

Stringy Floppy Characteristics

The basic control software for the Exatron Stringy Floppy system is stored in ROM (read-only memory) located inside the drive, making the system easy to use. The addressing of the ROM fits cleverly into an otherwise-unused gap in the TRS-80's memory-address space. The control software uses 4 bytes of read/write user memory. All you have to do to activate the control software is type "SYSTEM" to the Level II BASIC interpreter and then type "/12345". There are three ROM-based commands available: @LOAD, @SAVE, and @NEW.

To load a BASIC program from the wafer, you simply type "@LOAD*n*" (where *n* is a file number from 1 to 99), and within a few seconds the program will have been loaded into user memory. To store a BASIC program on the wafer, you type "@SAVE*n*". The system verifies that the program has been stored correctly, so this takes a little longer. To load and store machine-language programs, you use the same commands, adding arguments (in decimal radix) to specify the load-starting address, the length of the program, and the program's entry point. In

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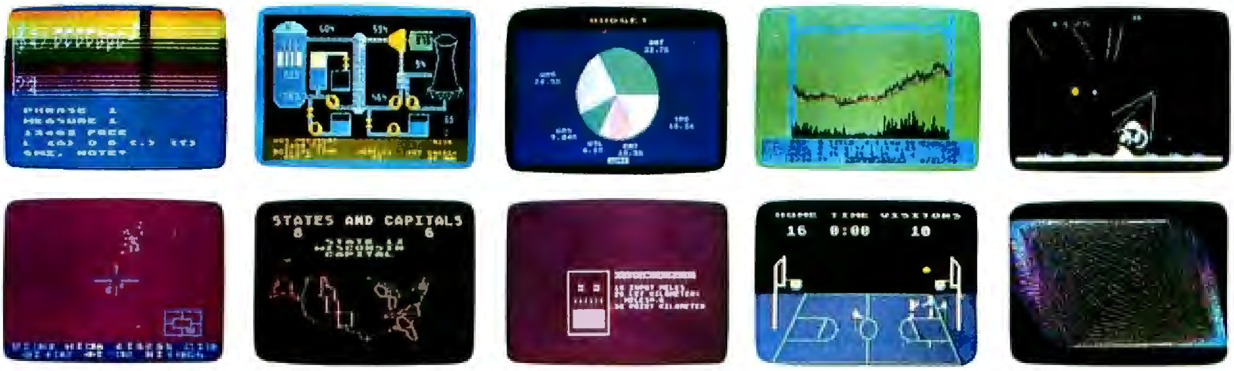

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And the ATARI ROM cartridge system also makes it easy to change languages. In short, your ATARI computer won't be obsoleted by future developments...*because it already incorporates the future.*

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addition, if you use "@LOAD*n*" from inside a BASIC program, it will chain program files while saving variables.

The @NEW command certifies a wafer for use. When you type "@NEW", the system writes a test pattern on the wafer, verifies it, and then displays the amount of storage space available on the wafer.

Storing data is just a little more complicated. A data-I/O (input/output) program that must be loaded into user memory is provided on a wafer. It takes up about 1 K bytes of memory. When loaded, it provides five more commands: @OPEN, @INPUT, @PRINT, @CLOSE, and @CLEAR. The uses of the first four are similar to corresponding commands in disk-based systems, and detailed explanations are included in the manual. The command @CLEAR is used for aborting open files and setting up I/O buffer space when you have more than one drive.

The system is not without some minor problems. First, no matter how well a tape-based system works, it is still a sequential-access system. That is, it may have to read all the files preceding the file you wish to access. (Since the Exatron drives are comparatively fast, this is less irritating than it sounds.)

Furthermore, the method of storage allocation leads to some interesting problems. If you read a program from a wafer, modify the code so it is longer, and then rewrite it onto the same wafer, the longer program will destroy the header of the file behind it. I have made it a policy (after losing several hours' worth of work) always to use a "scratch" wafer until I am absolutely satisfied there are no more changes to be made to a program. Another way to avoid this problem is to write the modified program as the last file on a wafer.

A second problem (one familiar to users of audio cassettes) is that there is no directory on a wafer of the files it contains. I use 3 by 5 file cards cut down to the size of a wafer to manually record the wafer's contents. I write the file names on the card and always keep that card with the wafer.

The last problem involves those 4 little bytes of user memory that the operating system uses. You won't be able to use every byte of memory in a 16 K-byte system. I was dismayed, at first, to find that I couldn't load some large programs from the Stringy Floppy. (Fortunately for devotees of games like the Scott Adams Adventures, a special loading routine has been developed for use with Adventure International products.) Of course, the 4 bytes are missed less by owners of 32 or 48 K-byte systems.

The 4 bytes will be relocated just below any area at the top of memory reserved for machine-language programs. If you don't reserve memory for machine-language programs, the 4 bytes will reside at the top of memory. If you have a machine-language program that attempts to load over these 4 addresses, either it won't load at all or it won't run correctly.

One way of increasing the data-transfer rate of the TRS-80 version of the Exatron Stringy Floppy system is by speeding up the Z80 microprocessor within the TRS-80. Exatron sells a speed-up kit that roughly doubles the processor's clock rate and the Stringy Floppy's data-transfer rate. Unfortunately, wafers recorded at the higher rate can be read only by a TRS-80 that has been speeded up.

Manufacturer's Support

I am impressed by the documentation and support provided for the Exatron Stringy Floppy. First, enough information about the operating system is provided in the user's manual to make assembly-language programming of wafer-I/O operations simple. Entry points to ROM routines for the various primitive functions (read block, write block, write file header, verify block, etc) and an

At a Glance

Name
Exatron Stringy Floppy

Use
High-speed mass storage on digital cassette

Manufacturer
Exatron Corporation
181 Commercial St
Sunnyvale CA 94086
(800) 538-8559
(408) 737-7111 (in California)

Price
First drive for TRS-80 Model I, $249.50
First drive with starter kit, $349.50; Second drive, $224.50
First drive for Apple II, $349.50; Second drive, $189.50

Dimensions
TRS-80 Model I, 6 by 4⅛ by 2⅜ inches (15.25 by 10.5 by 6 cm)
Apple II, 6¼ by 5⅞ by 3⅜ inches; (15.8 by 14.9 by 8.5 cm)

Features
TRS-80 Model I: on-board ROM-based operating system, 7200 bps data-transfer rate, LED indicators, automatic keyboard debounce; Apple II: LED indicators, built-in catalog function, 16,000 bps data-transfer rate

Additional hardware needed
TRS-80 Model I Level II computer and 40-pin ribbon connector; Apple II or Apple II Plus computer and interface card (card supplied with first drive)

Hardware options
TRS-80 Model I Speed-Up Kit (doubles processor clock rate and Stringy Floppy data-transfer rate), $19.95

explanation of the error-detection system are included.

Second, a starter kit is available that includes some immediately useful software: the data-I/O program, two I/O-demonstration programs, a machine-language monitor called ESF-80, which resembles Radio Shack's T-Bug, and a mini-data-base program. The starter kit also contains documentation, ten blank wafers, and a two-for-one ribbon cable for connecting the Stringy Floppy drive to the expansion port on the TRS-80 keyboard/processor module.

Third, for support after the sale, Exatron Corp has established the Exatron Stringy Floppy Owners' Association, through which a variety of software is available on wafer, including games and utility programs. Membership is automatic when you purchase a Stringy Floppy drive. The association also distributes instructions for modifying popular commercially sold programs to work with the Stringy Floppy drive. Such patches are available for the Electric Pencil word-processing program from Michael Shrayer Software and for the Editor/Assembler Plus from Microsoft Consumer Products. Members of the association are encouraged to contribute to the software collection and to a collection of hardware interface designs, sometimes in exchange for royalties.

Fourth, Exatron maintains a toll-free telephone number you can call if you need more help than you can get locally. The number is (800) 538-8559. California residents can call (408) 737-7111.

Other Planned Products

In addition to the version for use with the TRS-80 Model I, Exatron has recently announced a Stringy Floppy drive for use with the Apple II computer. The new system differs from the TRS-80 version in several ways. The operating system for the Apple will not be resident in ROM; it will be loaded into 6 K bytes of the Apple's user memory by a bootstrap routine when the Stringy Floppy system is activated, in much the same manner as popular disk operating systems. The Apple version will provide a catalog on each wafer, residing in the first file, and the standard data-transfer rate will be higher, about 16,000 bps. As the owner of a TRS-80, I envy these features.

Because Exatron is designing Stringy Floppy drives for some Commodore Business Machines computers and for the Radio Shack TRS-80 Color Computer, owners of these machines may look forward to having the Stringy Floppy added to the selection of peripheral devices.

Conclusions

- The Exatron Stringy Floppy system is an excellent low-priced alternative to slow audio-cassette data storage. The system appears to work well despite some minor bugs. Exatron apparently has worked hard to make both the hardware and its operation simple and efficient.
- Both documentation and support appear to be good, and toll-free telephone assistance is a reassuring asset.
- Thanks to the efforts of Exatron and the owners' association, an adequate supply of software converted to run on the system is available. ■

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Reviewing the Microcomputer Revolution

Ed Faber, President
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For the past five years, industry leaders have been telling each other about the microcomputer revolution, predicting it may even overshadow the industrial revolution. Of course, the beginnings of the industry go back more than five years, but 1976 marked the first anniversary of BYTE and the creation of ComputerLand, which celebrated its fifth birthday this fall by opening its 200th store.

With so many of the heady predictions of five years ago yet to be fulfilled, it's easy to lose sight of the changes we've already brought about. But one dream still unfulfilled is the emergence of a mass market for home computers. For ComputerLand stores, the home/entertainment market initially accounted for 50 percent of our sales. But by 1979, it represented only 25 percent, except at Christmas time. The home market has not dwindled; it has grown slowly while the business market has exploded. In fact, the events of the past five years might well be called the "office microcomputer revolution."

The three basic reasons for the faster growth of the business market show what's required to develop a mass home market:

1. Business is not afraid of computers; business people are accustomed to them and perceive them as useful.
2. Computers *are* useful to business; programmers have had 30 years to turn hardware into solutions.
3. Channels of distribution and support already exist for business computers.

None of these requirements has been completely satisfied for the home market. The public is afraid of computers. Until recently, most people didn't know where to buy a computer or how to support one, and they didn't see any benefit to owning one.

Making the benefits known is largely the responsibility of manufacturers. The first two requirements can be met by the existence of full-service retail computer stores.

From my viewpoint, the major achievement of the past five years has been the creation of the structures that will carry the microcomputer revolution to its next stages. Those structures have had more to do with merchandising than with technology. In other words, the real revolution springs not from technology but from our making that technology available to a mass market.

Many will read that statement with sorrow, even if they agree. The entry of giant manufacturers, the growth of global retail networks, the emergence of advertising campaigns involving celebrities and network TV—all of these have tended to squeeze out the starry-eyed, blue-jeaned innovators who started the ball rolling.

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BYTE Comment

sense of apprehension that prevails in the headquarters of successful companies. The question of the day seems to be "Who's gaining on me?" Instead of looking for a better and more valuable product, companies are aiming their strategies at the competition. Those who aren't afraid of IBM are afraid of the Japanese, or discounters, or Sears, or something.

Into this turbulent market I'd like to toss an idea, one we've used at ComputerLand and credit with our success: the market is honest. The companies that succeed are the ones that contribute value by building the best possible product and offering it at a fair price. I can think of no bigger mistake than for companies who became successful this way to begin reacting to what others are doing (or might be doing).

The potential market is much greater than anything we're competing for today. Any contribution to expanding the market can't fail to be repaid. The market will always have room for innovation, for products that improve on previous products or help solve new problems.

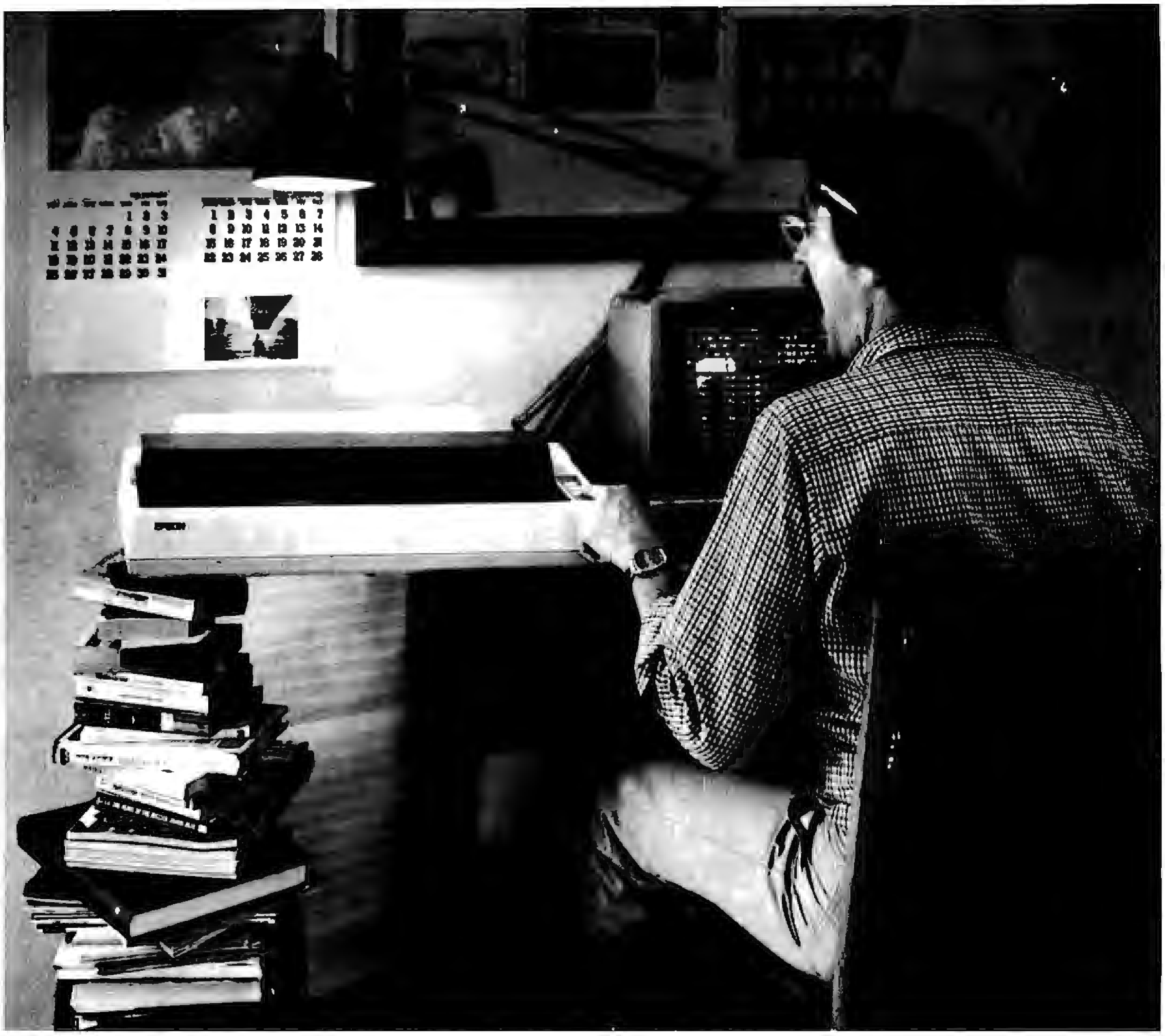
I believe much of the industry's apprehension grows out of a misperception about consumer marketing. Many manufacturers have not yet learned how to communicate to the general public or how to describe hardware benefits to computer illiterates. That doesn't mean computers should be sold like shampoo, with million-dollar ad campaigns and sex appeal. As shampoo marketers will tell you, ad campaigns are most important for products with few real advantages over their competitors. The market will always make room for a better product.

Innovation is also the answer for those who fear that Japan or some other country will steal the market through price erosion and superior manufacturing capacity. If the battle is fought on the basis of price instead of innovation, Silicon Valley hasn't a chance. If the battle is between cheaper and better, better will prevail wherever it comes from.

The companies to watch during the rest of this decade are the ones that concentrate on providng value to the end user. We happen to believe that value includes offering your products through full-service, full-support retail outlets. Be that as it may, the products with the most value to the end user are the ones that will succeed.

We are still on the threshold of the computer revolution; the greatest opportunities for manufacturers, retailers, and customers still lie ahead. No one now in the market or planning to enter it should fear anything more than the failure to bring value to the market. *That* is the challenge of the 1980s. ■

Occasionally, BYTE invites industry leaders to comment on topics related to the microcomputer industry. The opinions expressed by these authors are their own and do not necessarily represent the opinions of BYTE or its publishers.



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Needless to say, the specs on this machine — and especially at under $1000 — are practically unbelievable. But there's something about the MX-100 that goes far beyond just the specs; something about the way it all comes together, the attention to detail, the fit, the feel. Mere words fail us. But when you see an MX-100, you'll know what we mean.

All in all, the MX-100 is the most remarkable printer we've ever built. Which creates rather a large problem for those of us at Epson.

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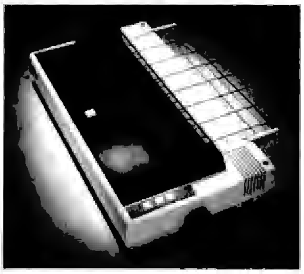

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System Review

The Datahandler from Miller Microcomputer Services

Allyn Richardson
POB 254
West Groton MA 01472

There are only two programs in my software library that I use constantly. One is the word processor that is helping me to review and edit *this* text. The other is The Datahandler from Miller Microcomputer Services. Written entirely in MMSFORTH (that company's version of the FORTH language for the Radio Shack TRS-80 Model I), The Datahandler does almost every job you expect of a personal computer except number-crunching—and it even does a little of that, as you will see.

For example, The Datahandler disk includes a checkbook and bank-transaction routine that is the best of its kind. It can generate a summary list of all transactions in a specified interval and provide a running balance for each. Adding a code letter to each entry that designates the source of deposits and the purpose of expenditures allows the output section of The Datahandler to give listings and totals for each class. With these summaries of your financial activities, the annual IRS formalities become a breeze.

There is also a mailing-list routine. Last year, with its help, I got through my entire Christmas-card list before Christmas for the first time in years. Previously, I got a few cards out by Christmas, some by St Valentine's Day, some by Easter/Passover, and many never made it at all. It took less effort to type all the names and addresses into the TRS-80 than to address one year's Christmas envelopes by hand, and I only had to type them in once. Now that the data is in the computer, I can select and automatically print self-adhesive address labels for the entire list or any desired portion, such as family members, personal friends, business associates, my MMSFORTH users' group, or monthly accounts. The address labels save a lot of work, and the system makes certain that nobody gets overlooked.

The Datahandler is also ideal for creating different catalogs, and it has built-in automatic cross-indexing. For example, I keep a catalog of all my phonograph albums on floppy disk. Each disk entry (called a *record* in computer data-base terminology) in the MASTER LIST data file corresponds to one album in my collection.

Each data record has five fields of information: an accession number, title, description, subfile, and code. The *accession* number tells *where* the phonograph disk can be found. When a file is resorted, this number stays with its file record, even though the records themselves are renumbered in a new sequence. The *title* field includes composer or performer, and the *description* includes the publisher's name, product number, and the number of separate musical pieces on the album.

The *subfile* field points to a separate listing in another file on the same disk containing more detailed

information. When all the subfiles have been built, requesting a musical selection will give a list of all versions in the collection, where each may be found (including the side and band of the album), when, where, and by whom each was performed, and a critical comment. You can see how this would be useful for a radio broadcaster handling requests from listeners while on the air.

Another worthwhile application is the ability to organize the contents of journals and periodicals. Finding that particular article in an extensive periodical collection can be quite a job. But if you have a Datahandler file of articles indexed by subject, author, title, when and where published, and a brief abstract, finding the desired article is no problem. An additional benefit is that Datahandler can scan all entries on a particular subject for relevant articles.

Of course, building this kind of data base from scratch takes time. If you are a member of a computer group, each member could build a file on a different publication with The Datahandler and all members could share their files.

The number of data bases is limited only by your imagination and your need to organize and control information. Photographers could catalog their prints, amateur radio buffs could keep their station logs, sports fans could keep individual and team records—the list goes on and on.

Anyone interested in learning about or using the FORTH language will appreciate several of the data files included on The Datahandler disk. A member of the MMSFORTH Users' Group has developed and made available a glossary of standard FORTH words (ie: program-coding commands) in Datahandler file format. This file can be accessed and used by anyone operating in FORTH, or it can be modified, updated, or extended using the Datahandler. Whole new vocabularies, such as the nonstandard FORTH words of which The Datahandler itself has been constructed, can be added. The routine allows listing by word class, gives a description of what the word does and how it is used, and includes a page reference to MMSFORTH's hard-copy documentation for more information.

Another data file, known as ASSEM, is included for assembly-language users or students. ASSEM contains the 149 commands of the Zilog Z80 microprocessor's instruction set and the associated page number in the TRS-80 Editor/Assembler user's manual from Radio Shack. Both are cross-referenced to the equivalent MMSFORTH Z80-assembler command (the same elements but with arguments and operators in reverse-Polish sequence) and (where applicable) the older MMSFORTH 8080-assembler equivalent. The Editor-Assembler manual provides a detailed description of the operation of each instruction.

The Datahandler's formatted hard-copy output is provided by the REPORT routine. You can print a line listing of all fields in each record of your file, or a selected subset. If the records are longer than one line, subsequent lines are indented and an extra line feed can be inserted between records. REPORT gives the option of generating a custom format, listing your file or selected subset with fields in any order. The format is completely under user control and can be set for your video screen or your printer's line and page length. It automatically truncates field lengths to fit your requirements. Unless you want it to, printer output does not include the various computer-generated prompts and operator responses of the interactive program.

Speed is one of the advantages of this data-base system, a direct result of the nature of the FORTH language (for specific information on this language, see the FORTH theme issue of BYTE, August 1980). The threaded interpretive structure of FORTH makes possible an indexed-sequential file organization. This combines the efficient use of memory space of a sequential file with the speed of random access. The memory efficiency is important because both The Datahandler program and the entire current data file are resident in the TRS-80 user memory to improve the response time of the system.

In FORTH, source code precompiles as it loads, and thus it occupies a minimum of memory. Once loaded, the compiled FORTH code is very fast. Precompiled code can be saved on floppy disk, reloaded, and reused. While it takes eighty seconds for The Datahandler source code to load and compile, the precompiled code loads

At a Glance

Name
The Datahandler

Type
Data-base-management utility program

Manufacturer
Miller Microcomputer Services
61 Lake Shore Road
Natick MA 01760

Price
$59.95

Format
5¼-inch floppy disk

Language used
MMSFORTH

Computer needed
Radio Shack TRS-80 Model I with a minimum of 32 K bytes of memory, one floppy-disk drive, and the MMSFORTH system.

Documentation
Reprint of the Scelbi PIMS manual, additional text from MMS, and built-in help functions to guide users through the program.

Audience
For persons who need a program to help organize and manage information using their TRS-80.

Additional comments
Requires MMSFORTH system, $129.95, for operation.

in less than eight seconds. Once loaded, the system disk is not needed for file operations because, as mentioned above, all the program code is in memory. The remaining space on the system disk can be used for file storage, or it can be removed and replaced with a data disk, transferring control to the new disk directory usually located at block zero. On multiple-drive systems, control can be switched at will from one directory to another for access to the files on each; it is even possible to have one directory refer to more than one disk. This can be complicated, however, requiring that such disks always be used as a set, each in its proper drive.

Both the source code and the precompiled version of The Datahandler are useful, and both should be retained. The source code can be easily modified, whereas the precompiled program cannot. Modified source code can be precompiled and saved on the disk; the documentation describes how this is done.

Once the program is loaded, how much space is left for holding a file? If you have a 32 K-byte TRS-80, about 9 K bytes. System overhead (device-control blocks, system stacks, etc) use about 3.5 K bytes while The Datahandler and the portion of the FORTH system it requires compile into about 19.5 K bytes. The remaining 9 K bytes of user memory are used efficiently, with data tightly packed. Each entry is linked to the next by a 2-byte address pointer to eliminate the vacant space at the end of partially filled or empty fields, which are often found in other data-base programs. For many personal applications 9 K bytes is enough; with a 48 K-byte system, the data space is about 25 K bytes, enough for a fairly large file.

If still more space is needed, you can split your data file into two or more parts, usually with no loss of convenience. For example, my phonograph-album file has 245 entries, which exactly fills my 48 K-byte memory space. To make room for further acquisitions, I split my file into a "classics file" and a "general file" (jazz, folk and humor). A large mailing-list file could be divided alphabetically by addressee, or by zip code for presorted bulk mailings.

Having the entire file resident in memory is much faster than a system which uses frequent time-consuming transfers to and from disk. My memory-filling phono-record file has entries stored in order of accession number; resorting to alphabetic order by title takes 13.2 seconds. Sorting by code designation within the alphabetic sort increases this time to 14.1 seconds. Up to ten successive levels can be sorted. Sorts are the slowest of the file manipulations. Other operations occur as fast as you can punch the keys.

There are also small conveniences that speed up the human end of the operation. For example, when entering a group of checks written on the same day, you need only enter the date for the first entry; entering a semicolon in the date field of the

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Hayes Microcomputer Products Inc. 5835 Peachtree Corners East, Norcross, Georgia 30092 (404) 449-8791 subsequent entries copies the date information from the previous entry. This semicolon function can be used with any field, whether you're entering a series of articles from the same magazine, friends in the same city, or addresses with the same zip code. When updating a record, a null entry leaves the field unchanged, while entering a couple of spaces erases the previous contents, and any valid entry replaces the old data.

For search-and-match operations, you do not have to enter the exact field desired; The Datahandler will locate close matches if so directed. For example, if you want to find the account of Dr. Neilson but don't know the correct spelling of the name, you type in the name string (the target of the search in each record in this case) as "N??LS?N", and any alternative spellings will be located (eg: NIELSEN). The wild-card character, ?, indicates that any character in that location is acceptable. Even if you have lowercase capability and have recorded a name with initial-capital letters, instead of using all uppercase, it can still be located on the first try. By changing the program constant ?UL from its default value of 0 to 1 (the command in FORTH to do this is { 1 ?UL C! }), all lowercase characters will be regarded as uppercase for the purposes of string matches. This is very convenient for those with lowercase capability on their TRS-80.

Product Support

One of the most attractive features of The Datahandler is the excellent documentation. The well-known Scelbi PIMS (Personal Information Mangagement System) program, written in BASIC, provided the concept upon which The Datahandler was built. By arrangement with Scelbi Computer Consulting, the very fine PIMS user manual is supplied as the main documentation for The Datahandler. As in the original PIMS, The Datahandler leads you by the hand with the HELP command, which displays all available options, then supplies prompts that tell you what to do next. Additional text takes you step by step through all the operations, from loading the program to adjusting a custom report format (the most complex operation for a beginner), and using sample practice data files included with The Datahandler disk.

Beginners will find The Datahandler easy to use. Only an extremely experienced user will not require the prompts. Not only do they guide you through all the program options, they provide great flexibility in formatting a custom report. However, the versatility and interactive nature of this program can be a disadvantage. Some options or parameters will not change from day to day, and it can be a nuisance to have to reenter them every time.

This minor nuisance can be overcome if it becomes a problem. For those users familiar with FORTH programming, custom modification of some of The Datahandler routines (such as replacing the #IN routine, which receives keyboard input, with the desired parameter as a literal) is not too difficult. It's easy to eliminate unnecessary inputs while retaining needed flexibility. Even neophytes who know how to use the full-screen FORTH editor will learn a lot in the process.

If, on the other hand, you have a business application and want no part of programming, but do need custom modifications, the group at Miller Microcomputer Services (which includes Tom Dowling, author of both MMSFORTH and The Datahandler) can create a custom version. The typical cost is $500 to $1000, depending on the extent of the modifications. This is competitive with many business systems with fewer features, running twenty times slower in BASIC.

To get new customers started more easily (those who purchase both the MMSFORTH and The Datahandler disk with single-system licenses), MMS will provide a third disk customized for your system configuration and precompiled for eight-second loading. Though the firm does not promote this service, it is available on request for an extra $10.

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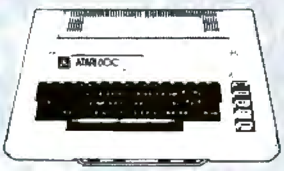

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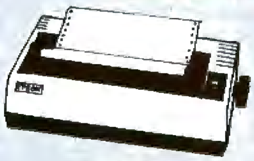

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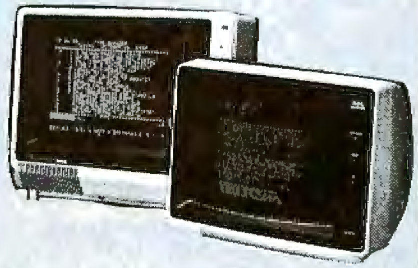

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The Datahandler program is upgraded and improved constantly. New capabilities beyond those already mentioned are often suggested by users. Features are added to the standard version only if their general usefulness is considered worth the extra memory they take away from the available file space. Other more specialized functions are distributed via the *MMSFORTH Newsletter*.

The user's original floppy disk may be returned to MMS for upgrading at any time. The fee for upgrading is $10, plus $1 shipping and handling. Fifteen dollars must be sent by the customer with the disk; the extra $4 is returned with the upgraded disk unless the original arrived damaged and had to be replaced.

The first two issues of the *MMSFORTH Newsletter* are complimentary to new MMSFORTH and Datahandler licensees. A subscription of four more issues costs $10. Considering the valuable information contained in these newsletters, most users will find them well worth the price.

The September-October 1980 issue, for example, provided information on a new utility disk providing a Z80 assembler, floating-point mathematical operations, a program for looking up source-code definitions of FORTH words, and a routine for converting lowercase text to uppercase. The issue also explained and listed the programming needed to access the interrupt-driven clock in the TRS-80 Expansion Interface and its use in timing operations. Also included was a listing and discussion of the latest addition to MMSFORTH version 1.9, which reports available memory space on the directory-menu screen whenever DIR is entered, and uses no additional memory space itself. There were other suggested improvements a user could make without waiting (and paying) for a full upgrade, news of coming events, short tutorial articles by Tom Dowling, and a listing of user-group contacts scattered throughout the nation.

The Datahandler is a personal data-base management and utilities

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package of impressive capability, well documented and easy to use. If you want to make the most of your TRS-80, this program provides the best way I know to put it to work organizing and managing information. If you have or can upgrade to a 32 K-byte system with one or more floppy-disk drives, it is well worth the price to acquire MMSFORTH, if only to use The Datahandler. With 48 K bytes of user memory and a printer, many small-business tasks can be managed very capably. For the FORTH programmer, The Datahandler can be used as a starting point for a wide variety of custom applications, since source code is provided and FORTH programs are characterized by ease of modification and extension. Programs run about twenty times faster than equivalent operations in BASIC and compile into relatively little memory space.

The Datahandler, with complete documentation and a single-system license, sells for $59.95. MMSFORTH with license and equally good documentation is $129.95, giving the TRS-80 user an additional powerful computer language and operating system.

I have the first Datahandler sold by MMS and have been an active member of the users' group since it was formed. In this time I have heard of no user who is less than enthusiastic about the program's features and many uses. Most users of a suitably configured TRS-80 should find many constructive ways to put The Datahandler to work.

Conclusions

- The Datahandler is a data-base management utility for TRS-80 Model I microcomputers, ideal for personal use and for many business applications.
- It requires at least 32 K bytes of programmable memory and one floppy-disk drive. A memory size of 48 K bytes with two drives and a printer complete an ideal system for most uses.
- MMSFORTH is required as the operating system and also gives you a powerful new language with many advantages. No knowledge of FORTH is needed to use The Datahandler.
- Advantages include excellent documentation and interactive programming for easy use by anyone, many convenient features to speed keyboard operations, and very fast computer operations, including fast sorting. Routines are included for maintaining a mailing list, printing address labels, checkbook balancing, and custom reporting. The Datahandler is completely flexible in number and size of fields and field titles. Custom report formats for special needs can be tailored to order by MMS and by many other competent programmers. A wealth of powerful routines in source code are provided from which the professional can rapidly assemble custom software.
- Disadvantages are limited to the fact that very large files which cannot fit within the computer's user memory must be divided into sections that do fit. For the applications for which this utility was primarily intended, dividing files is seldom necessary and causes little inconvenience when it is; the speed of operation achieved by having the entire file in user memory is of more value. I know of no other major disadvantages.
- The cost of the entire Datahandler/MMSFORTH package (with single-system licenses and documentation) is, in my opinion, very reasonable and would not be out of line for The Datahandler alone.
- For the programmer, source code is provided and custom modification is not difficult. In fact, this one utility program can be used as the starting point for a wide range of special application programs. ■

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Microsoft Softcard

Mark Pelczarski
1206 Kings Circle
West Chicago IL 60185

The Microsoft Softcard offers Apple owners increased flexibility and a strong alternative or complement to the Language System from Apple. At a suggested retail price of $399 Softcard comes with version 2.2 of the CP/M operating system and Microsoft's BASIC-80, version 5.0.

In addition, a number of other Softcard support products are available, including Microsoft's FORTRAN and COBOL, an assembly-language development system, a BASIC compiler, muMath and muLisp, and 16 K-byte memory expansion cards. None of these are inexpensive; for example, the COBOL language system retails for $750 (making FORTRAN seem like a comparative bargain at $195), but the point is that you can now have these languages, plus a variety of software already written for CP/M, on your Apple.

Overview

The Softcard package comes with the card, 13- and 16-sector disks, and two thick manuals. The card is manufactured for Microsoft by California Computer Systems of Sunnyvale, California, and was designed by Don Burtis of Burtronix in Huntington Beach, California. With the exception of slot 0, it works in any of the Apple peripheral slots and the Softcard package will work alongside the Apple Language System. The Language System actually extends the ability of the Softcard system by providing an extra 12 K bytes of programmable memory. The Softcard is not compatible with the Apple III. It does work with all of the 80-column boards now available for the Apple II.

The software supplied is the CP/M operating system and two versions of BASIC. The 13-sector disk contains MBASIC, which is Microsoft's ANSI (American National Standards Institute) compatible BASIC-80, with a few additions to accommodate Apple's low-resolution graphics features. The 16-sector disk also contains GBASIC, which includes high-resolution graphics commands. CP/M, the operating system, is an abbreviation for Control Program/Microcomputer, and is licensed by Microsoft from Digital Research, Inc. This version of CP/M includes a variety of disk and transfer utilities, plus an 8080 editor/assembler/debugging utility. The software was produced by Neil Konzen, a name that will be familiar to anyone fortunate enough to own Synergistic Software's Program Line Editor, another of Neil's Apple creations.

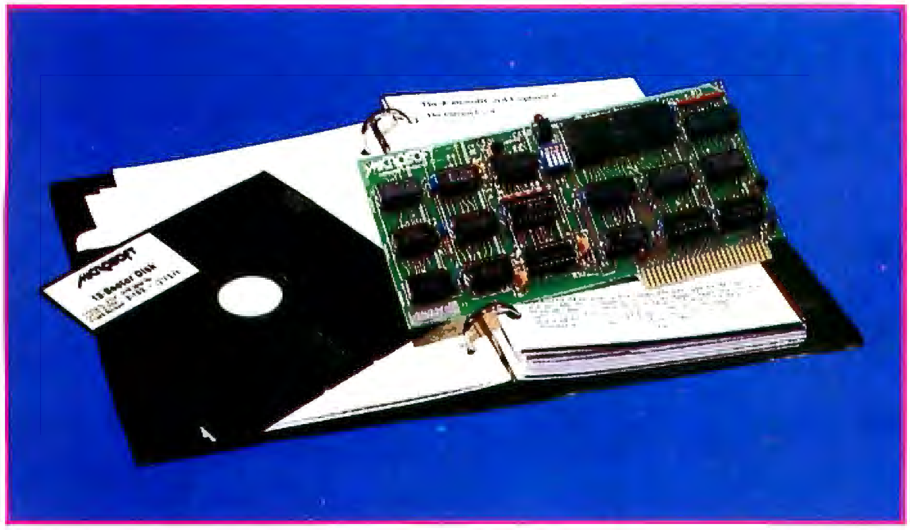

Photo 1: *Microsoft's Softcard package. Included are the card itself, software for the Apple II, and a two-volume set of manuals (with installation instructions, information on using CP/M, hardware details, Microsoft BASIC reference, and documentation on other utilities.*

Using the Softcard

The two system manuals are very thorough and provide simple to very technical information. One is for CP/M, the other tells how to use BASIC 5.0 and the included software utilities. The first subject covered is how to back up the master disk. The beginner will probably want to go from there to more familiar ground and play with some of the BASIC

About the Author

Mark Pelczarski is a software consultant and Director of Micro Co-op, a consumer buying cooperative. He previously was Editor of SoftSide magazine, and a computer science instructor at Northern Illinois University.

Most small system users think all micro-
mputers are created equal. And they're
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dling, high technology and reliability (and
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commands, learning how to use the operating system as the need arises.

BASIC 5.0 is a nice way to convert to a structured language. If you're already familiar with BASIC, Applesoft or another version, you won't be trying to learn a new language from scratch. The advantages of BASIC 5.0 include several new commands that support structured programming. (See table 1 for a list of enhancements and their descriptions.)

The most convenient additions are the inclusion of the ELSE clause in the IF-THEN statement, the PRINT USING statement for explicit formatting of output, the inclusion of real disk commands, replacing the ungodly PRINT Control-D commands of Apple's DOS, and BASIC's version of a DO WHILE loop: WHILE/WEND. An example of the latter, paraphrased, would be: WHILE this condition is true, keep repeating all the commands before the WEND statement. This version of BASIC is also compatible with current ANSI standards, so the use of BASIC programs written

Text continued on page 158

At a Glance

Name
Microsoft Softcard

Manufacturer
Microsoft Consumer Products
400 108th Ave NE
Bellevue WA 98004
(206) 454-1315

Price
$399

Computer needed
Apple II, 48 K-byte minimum storage, and a disk drive

Hardware
Peripheral card that fits in any of the Apple expansion slots (except 0). The microprocessor is a Z80A

Software
CP/M, version 2.2, from Digital Research, and Microsoft BASIC 5.0, 13-and 16-sector versions with Apple enhancements

Documentation
Two manuals, approximately 400 pages, one primarily about CP/M, the other about BASIC 5.0

Options
Microsoft's FORTRAN, COBOL, muMath, muLisp, assembly-language development system, and BASIC compiler; 16 K-byte memory expansion card (or the Apple Language System)

Audience
Those seeking to increase the software flexibility of their Apple II computers

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Some new features of BASIC 5.0:

AUTO—Automatic line numbering when entering programs.

BEEP—Sounds the "Bell," instead of using an invisible Control-G.

Boolean operators—In addition to AND, NOT, and OR, BASIC 5.0 has XOR (exclusive OR), IMP (implication), and EQV (equivalence).

BUTTON—Instead of PEEKing at locations to find if a paddle button is pressed.

CALL—Can be used to call Z80 and 6502 subroutines, and pass parameters to them.

CHAIN—Runs another BASIC program, allowing variables to be passed.

COMMON—In conjunction with CHAIN, passes variables to another program.

Disk I/O—OPEN instead of PRINT ""D OPEN"; likewise CLOSE, GET#, INPUT#, WRITE#, and so on.

EDIT—An in-line program editor.

ELSE—As in: IF X = 0 THEN PRINT "ZERO" ELSE PRINT "NOT ZERO"

Functions—New string functions INSTR, which searches for a substring, and STRING$, which allows repetitive string definition.

HSCRN—Tells whether a point on the high-resolution screen is on or off.

LPRINT—Outputs a line to the printer, instead of using: PR#1 : PRINT.

MERGE—Allows two program files to be merged.

MOD—Finds the remainder of a division. This was available in Integer BASIC, but it's not included in Applesoft.

PRINT USING—Allows formatting of output, and is much more flexible than HTABs and VTABs.

RENUM—Allows you to renumber your program lines.

SWAP—Interchanges the values of two variables without using an intermediate variable.

User Functions—Can be defined with multiple arguments, instead of Applesoft's single-argument functions.

Variable types—Includes integer, single, and double precision; up to 16-digit accuracy.

VPOS—Finds the vertical position of the cursor.

WHILE/WEND—A loop structure similar to FOR-NEXT, except it checks for a condition each time instead of counting.

Applesoft commands not supported:

Cassette LOAD and SAVE, STORE and RECALL—Cassette functions are not included at all.

ESC editing—Replaced with the EDIT function for line editing.

FLASH—No flashing characters.

HIMEM, LOMEM

Shape Tables—None of the shape functions, DRAW, XDRAW, ROT, or SCALE, are supported.

IN#, Pr#—Commands are already device oriented.

Table 1: *Comparison of the features available in Microsoft MBASIC 5.0 as supplied with the Microsoft Softcard and Applesoft BASIC.*

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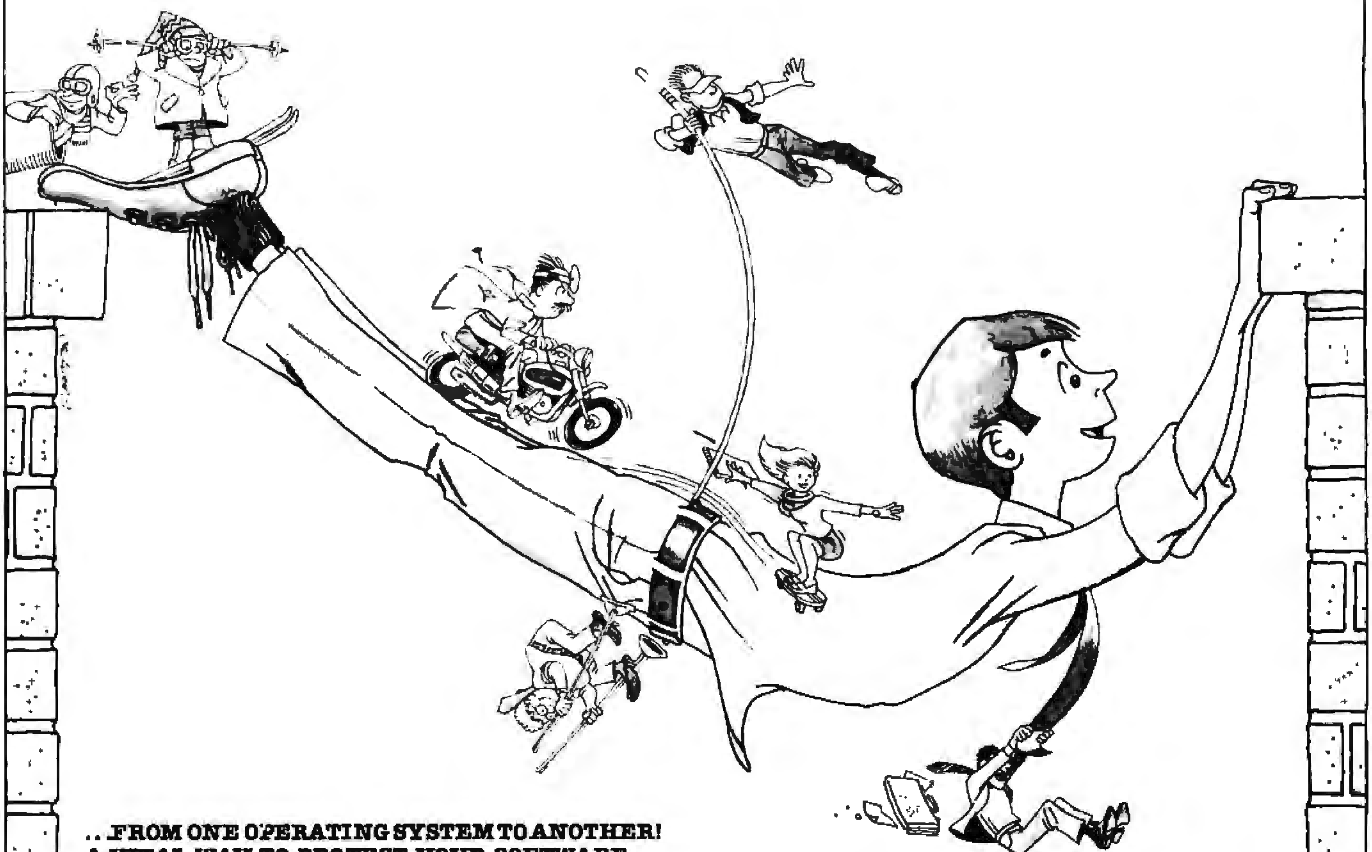

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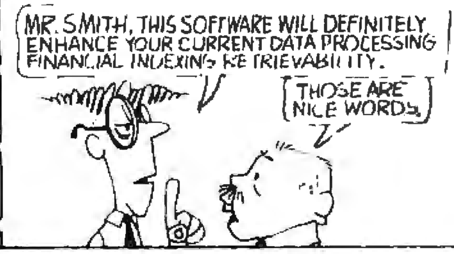

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Text continued from page 154:

for other machines using ANSI BASIC is possible.

After the language is loaded, about 14 K bytes of working storage are left on a 48 K-byte system. Hence, there are advantages to having the Language System or the optional 16 K-byte memory board. Either choice gives an added 12 K bytes of working storage. A 4 K-byte slice of that memory range is inaccessible: those are hexadecimal memory locations C000 thru CFFF, which are allotted for peripheral card I/O by the Apple. Another 4 K bytes, for the 6502 microprocessor's stack, the text screen, and other miscellany, are not available to the Z80, so Microsoft refers to 44 K- and 56 K-byte systems, rather than 48 K- and 64 K-byte systems.

CP/M for the Softcard is a complete version of the operating system. The command files provided with CP/M are shown in table 2. The standard CP/M 8080 assembler is included, along with a line-oriented text editor and DDT (Dynamic Debugging Tool) for machine-language programmers. Utilities are also available for transferring files from one device to another PIP (Peripheral Interchange Program), simulating batch jobs with disk input files (SUBMIT), dumping the hexadecimal contents of any file (DUMP), and transferring text and binary files from Apple DOS disks (APDOS).

Using Other CP/M Software

A language or operating system is of little value if it is nonstandard or can't be used with existing software. Softcard provides a DOWNLOAD program, a listing, and programming details for an UPLOAD program, that when loaded into respective systems (DOWNLOAD for the Apple, UPLOAD for another CP/M machine) allow the transfer of CP/M files from another CP/M system to the Apple through a serial RS-232C port. This does, of course, assume that you have the appropriate serial interfaces and another CP/M system available. A working knowledge of 8080 assembly language is also necessary for implementation of the UPLOAD program.

Another possible solution is to transfer CP/M files to an Apple DOS disk as a text file and convert that file to a CP/M file using APDOS. However, the text file created with the Apple DOS will use only a carriage return as a delimiter, while CP/M requires a carriage return and a line feed. Depending on the language, at this point, more tinkering is needed for the Softcard to understand your program. The saving grace to all non-tinkerers is the fact that companies such as Lifeboat, Peachtree Software, Microapt and Structured Systems offer their CP/M software already on Apple-format disks. Also, the Computer Shack in Pueblo, Colorado, will, for $10, download any CP/M program you send them for use with the Softcard.

Using the 6502 from CP/M

It is possible for programs written for the Softcard to call routines writ-

Text continued on page 162

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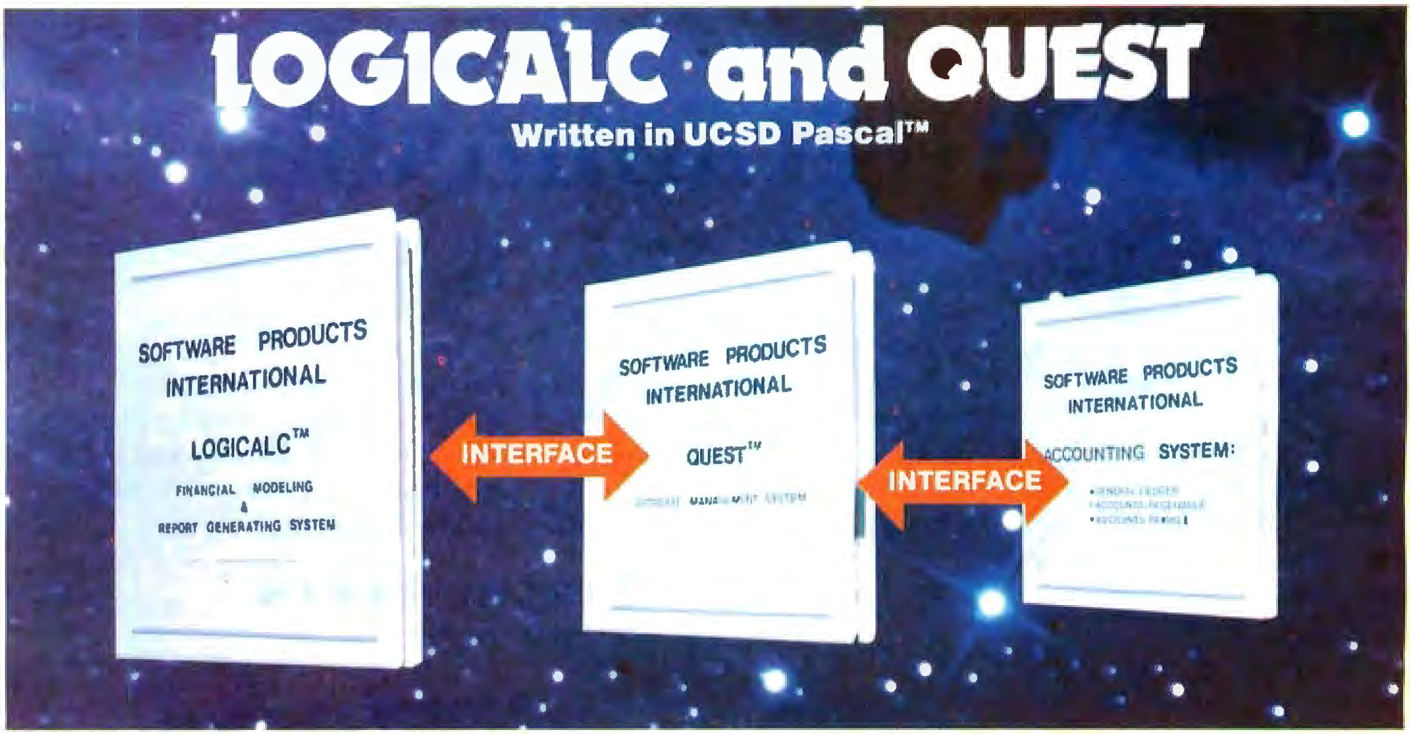

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1002

Built-in CP/M Commands:

DIR—Lists the disk directory.

ERA—Erases a file or files from disk.

REN—Renames a disk file.

SAVE—Saves a file to disk.

TYPE—Displays the ASCII contents of a disk file.

USER—Used to divide the disk into up to 16 separate user areas. USER specifies access to one of those 16 areas.

Transient Commands:

ASM—Loads the 8080 assembler and assembles a program from disk.

DDT—Dynamic Debugging Tool, an interactive machine-language debugging aid, allows program traces and editing.

DUMP—Displays the hexadecimal contents of a file.

ED—CP/M's editor utility.

LOAD-Creates a transient command file from a machine-language file on disk.

PIP—Peripheral Interchange Program, allows you to copy, merge, print, and load disk files.

STAT—Provides statistical information about disk space and device assignments.

SUBMIT—Executes the CP/M commands put in a special file with the editor program. Allows programs and commands to be batched together as Apple's EXEC command does.

CP/M Software:

APDOS—Allows transfer of ASCII and binary files from Apple-formatted disks to CP/M disks. This program requires two or more drives and cannot write CP/M files to Apple DOS disks.

CONFIGIO—Allows you to configure CP/M to your system, such as upper/lower case, 80 columns, and redefinition of keyboard characters for external terminals.

COPY—Disk copy utility.

DOWNLOAD—In conjunction with the UPLOAD program on another system, allows transfer of CP/M files to the Apple CP/M system.

FORMAT—Formats new disks.

GBASIC—BASIC 5.0 with high-resolution graphics enhancements, provided on the 16-sector disk only.

MBASIC—BASIC 5.0, with some additional commands for use with the Apple.

RW13—Allows the 16-sector CP/M to read and write on a 13-sector CP/M disk.

UPLOAD—A listing of a program to be used on another CP/M system in conjunction with DOWNLOAD for transferring of CP/M files. A working knowledge of assembly language will be necessary to implement this program on another system.

Table 2: *List of the features and utilities of the CP/M operating system included with the purchase of a Softcard.*

Text continued from page 158:

ten for the 6052 processor. The Z80 is enabled with a memory write to a specific location. This *soft switch* can be toggled back to the 6502 with a similar write performed by the Z80. 6502 subroutines may be called by putting the subroutine address in a predesignated location, then toggling the soft switch. Values can also be passed to the 6502's A, X, Y, and status registers through another set of specified memory locations. The only confusion may come from the fact that the Softcard re-maps the Apple's memory to conform to CP/M standards. This means that the same location will have different addresses under the 6502 and Z80 modes. Apple's zero page has been moved to the top of the Z80's memory, so the Z80's location zero is actually hexadecimal 1000 to the 6502. This may sound confusing, but the adjustment is not difficult.

Conclusions

Because of the flexibility it offers Apple users, I consider the Softcard an excellent buy. Despite the introduction of many new and often better languages, three of the first popular computer languages (FORTRAN, COBOL, and BASIC) continue to enjoy the widest use. Although I'd like to jump on the Pascal bandwagon, I don't think that it and other languages will replace any of the above three. New languages will be used, but the trend is that existing languages continue to evolve to keep pace with the times. Look at BASIC. It's hardly recognizable from its original version or the version of FORTRAN of which it was supposedly a subset. The cost of rewriting software and retraining programmers is just too high to allow drastic changes or entirely new languages. The Softcard lets you choose among the many standards of the industry as it now exists. It has the most current version of BASIC, is capable of handling COBOL and FORTRAN, and uses CP/M, the closest there is to a standard operating system for microcomputers. The price is reasonable, and it works. ■

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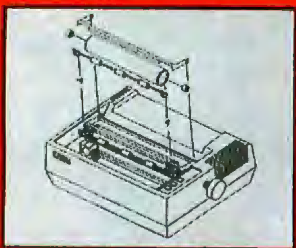

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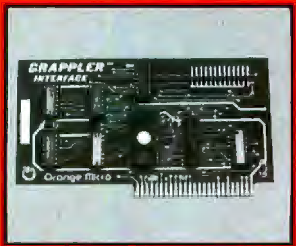

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CourseWare Magazine

Elaine Holden
Reading and Language Arts Coordinator
Merrimack School District
Merrimack NH 03054

One of the problems limiting the use of microcomputers in the classroom is the lack of good educational software. This comes as no surprise, since hardware developments have always outpaced software developments. The problems of generating educational software, however, are compounded by the fact that most educators do not have the technical skills to write good programs and, conversely, most good programmers do not have the educational background to design useful programs.

CourseWare magazine was started to fill this gap. Its philosophy, as stated in the introduction:

"Each issue of *CourseWare* magazine will include a C-10 cassette containing at least two programs selected from the ten pre-college curriculum areas of business, consumer economics, English, fine arts, foreign language, industrial arts, mathematics, physical education, science, and social studies, or from the area of teacher-assistance programs. Each student program will be accompanied by a teacher guide, a student guide, worksheets (if applicable), suggestions on how to adapt programs for individual lessons, a description of variables used in the program, and a listing of the program. Teacher programs (computer-managed instruction, computer-supported instruction) will be accompanied by a user guide."

In using the materials given in the Apple II version of

Photo 1: *September 1980 issue of* CourseWare *magazine. Each issue includes a cassette tape of the programs in that issue; separate versions are available for use with the Apple II or II Plus, Commodore PET, or Radio Shack TRS-80 Model I.*

At a Glance

Name
CourseWare magazine
(September 1980)

Type
Software and documentation for classroom use

Publisher
CourseWare
4919 N Millbrook #222
Fresno CA 93726

Price
$12.95 (or 5-issue subscription, $50)

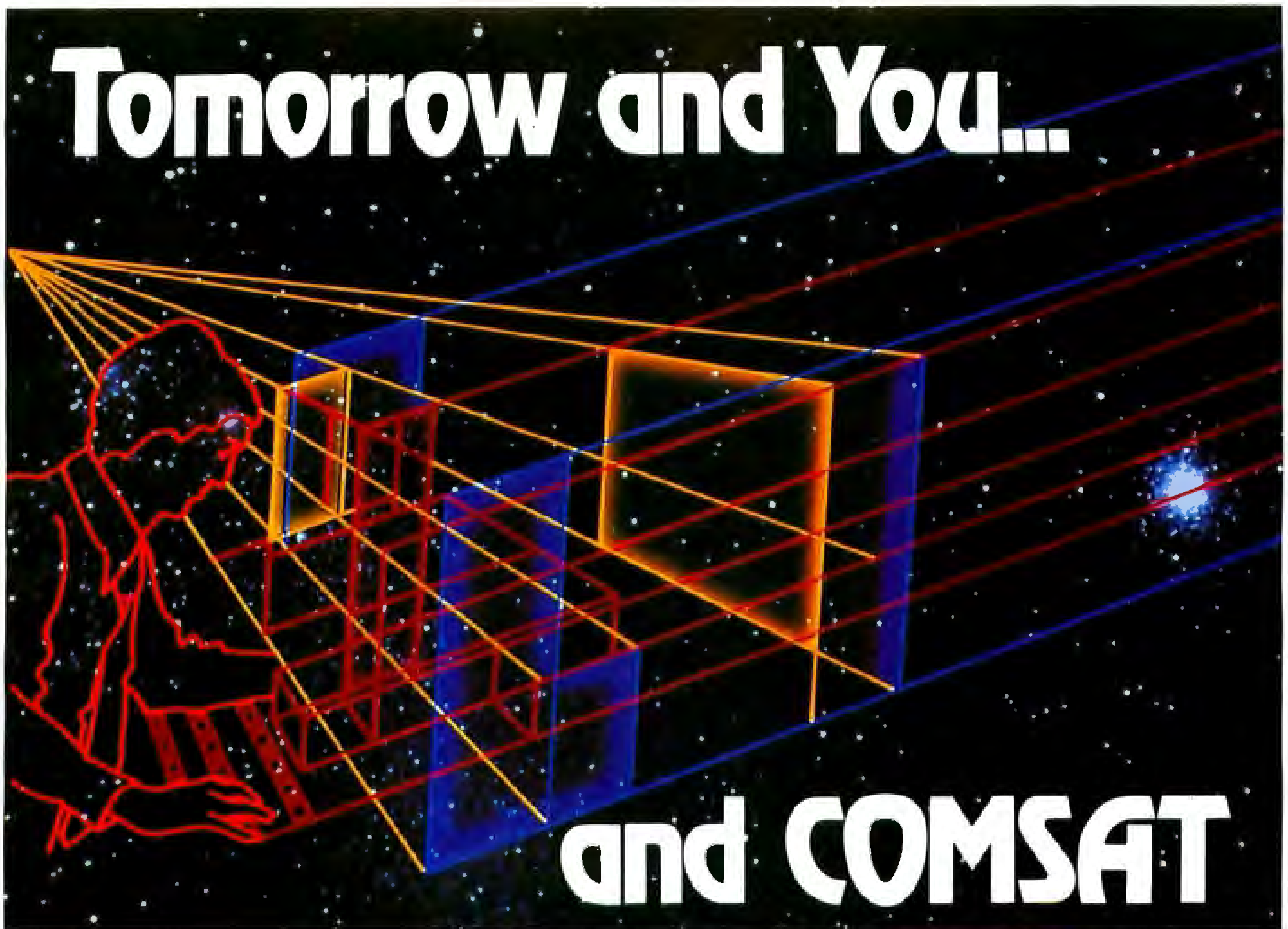
Format
Cassette

Language used
BASIC

Computer needed
Apple II or II Plus, Commodore PET, or Radio Shack TRS-80 Model I

Documentation
28 pages, in a 3-ring binder

Audience
School teachers with access to one of the computers listed above



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The Price

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and requires no special environment. Zilog provides a complete eight user system, including system software, 256 KB of main memory, a 24 MB Winchester disk and 17 MB tape cartridge back up, along with expansion capabilities, all for only $29,950. (U. S. list.)

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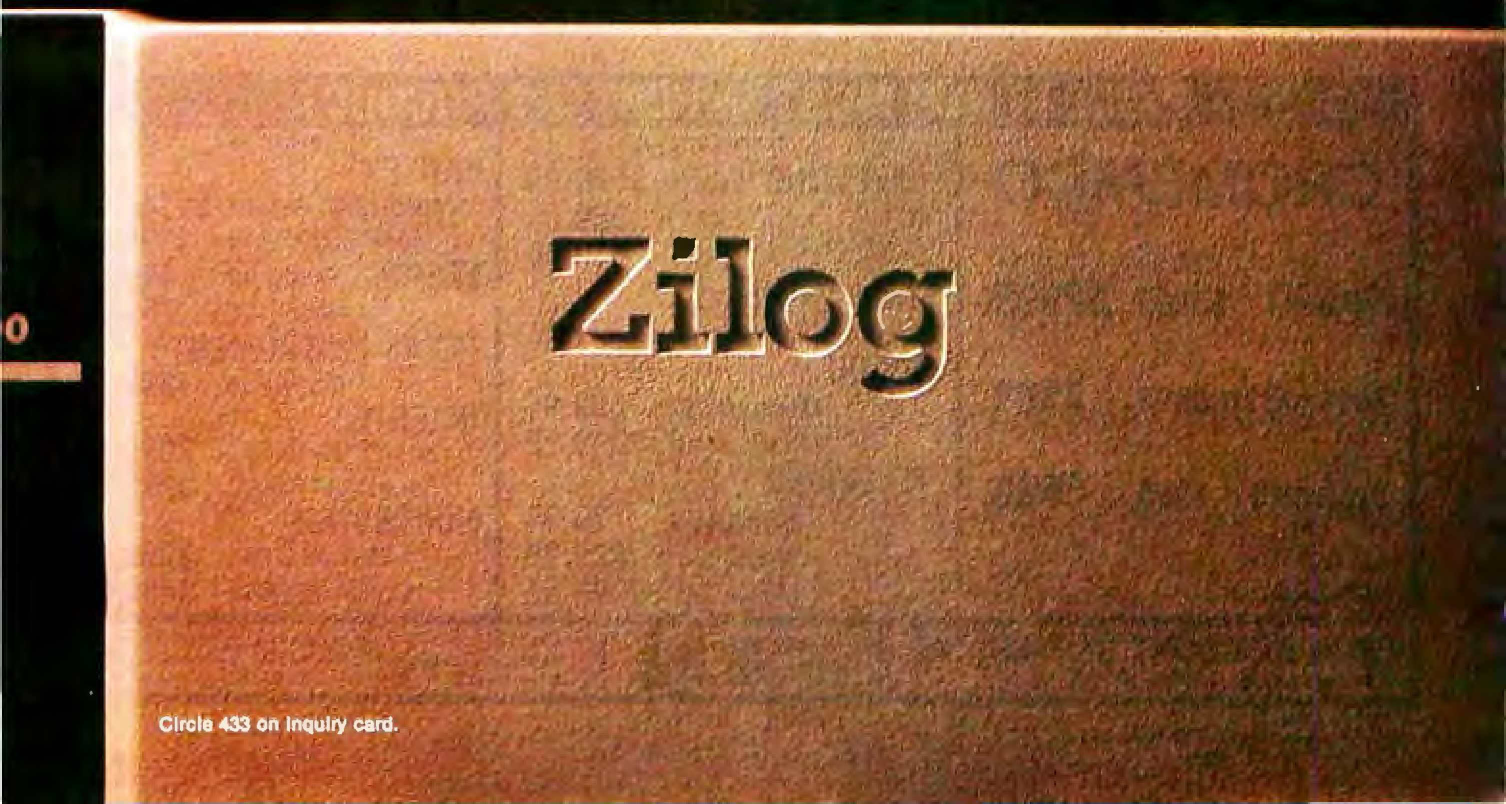

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the first issue, September 1980, I found that these objectives were met.

SPELL 'N' TIME

I loaded the first program, SPELL 'N' TIME, without any problems. SPELL 'N' TIME is an electronic version of the traditional spelling bee, in game format. The drill can be used at all grade levels and for any subject. It is especially useful in subjects where specific vocabulary recognition is important.

SPELL 'N' TIME works like this: a student starts up the program and the computer prints "watch carefully." A box with an arrow pointing to it appears on the screen. The program displays and erases a word in the box, and the student spells the word in a box below. If the answer is correct, the computer prints "Good job!," and another word is presented. If the answer is incorrect, the program gives a short, nonthreatening sympathy message, "Sorry, try again." After one misspelling, the word is displayed syllable by syllable, and the student tries to spell the word again. If he/she does not spell the word correctly the second time, the word is continuously displayed while the student types in the word correctly.

This process continues for each word in the list. The number of correctly and incorrectly spelled words is displayed at the bottom of the screen. When the last word is finished, the computer gives a list of the incorrectly spelled words, which the student is to copy onto his/her worksheet (a master copy is provided in the documentation).

To the student, the program is a game, since the objective is to finish the word sequence as quickly as possible. All students can experience success:

- the presentation time of words depends on the individual's word recognition and spelling accuracy
- the word selection can be matched to the student's ability level
- there's immediate positive feedback for a correct response

An introduction states what the program does, what computers it runs on, its objectives, and why it is useful in a classroom. Explicit instructions tell how to change the number of words to be used (one program line must be changed), and how the teacher can change the actual words to be used (by typing the words, hyphenated with dashes, into one or several DATA statements). With only minimal computer experience, I was able to make both kinds of changes and save the changed program under a new program name.

By using the program, the teacher may leave the quizzing to the computer and give special attention to each student's needs by monitoring the student's response and revising the word list.

Studies show that the best way to evaluate spelling is with a written test. Improvement in spelling often comes from regularly administered tests based on misspelled words found in the student's work and later corrected and practiced. SPELL 'N' TIME reinforces this basic concept. Students can practice on teacher-selected words and later take a written test. This testing method closely approximates methods recommended by current studies and, as such, the teaching matches the testing. Consistent teaching and testing eliminates confusion on the part of the student.

QUIZSTAT

QUIZSTAT, the second program in the September 1980 issue of *CourseWare*, is a management program. It gives the teacher statistics on classroom performance on a given quiz. Only the memory capacity of the computer limits the number of students this program can handle.

For a given test, QUIZSTAT tabulates the number of students who missed each question, the percentage of students who made the incorrect response, the overall

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class average, and a grade-percent scale. The information is entered and displayed in several frames. The first frame asks for the class size, the number of questions in the test, and other identifying information. In the second frame, the teacher types in the number of each question that was answered incorrectly (once for every time it was answered incorrectly). When this process is finished, the third frame shows a summary of each question, including the number and percentage of students who missed it. If 50% or more missed any given question, an asterisk appears beside the question number. A record sheet is provided in the program documentation for the teacher to copy the information from this frame. Finally, the fourth and fifth frames give the class average and a grade-percent scale. The program allows the teacher to correct transcription errors during data entry.

In its simplest use, the program helps the teacher determine which classes and which subject areas need work. When used in a pre-test/post-test system, the analysis of the pre-test data shows the teacher which material needs to be emphasized, and the analysis of the post-test data shows which areas were most effectively taught.

Conclusion

One criticism I have is that I would like to see documentation of certain statements made in the magazine. For example, in the introduction, passing reference is made to "four surveys made during the past five years." How comprehensive were these surveys? What were the actual results? That is not stated. Educators might want to see the research so an address should be given.

In a second example, questions answered correctly less than 50% of the time were flagged by the QUIZSTAT program. My question to the program designers is "what research supports this seemingly arbitrary figure?" I feel that at least 85% of all students, a standard figure for many educators, must pass a given test question. I hope these problems with documentation will disappear in future issues.

The two programs in the issue I reviewed are useful and complete. The importance of supporting the programs with worksheets and documentation cannot be overstated. One of the most exciting aspects of using this software is that program improvements and new ideas come to mind immediately, causing me (and, I hope, other teachers) to see new uses for the classroom computer.

The editor of *CourseWare,* Dr Dan Isaacson, is on the faculty of the School of Business and Administrative Sciences at California State University in Fresno, California. The material in the first issue reflects a knowledge of teachers' needs as well as a proficiency in computer science. [**Editor's note:** *At the time at which this review went to press, three issues of* CourseWare *had been published. ...GW*] Efficient and creative use of the computer in the classroom will depend on programming efforts such as this. ■

DIF: A Format for Data Exchange between Applications Programs

Candace E Kalish & Malinda F Mayer
DIF Clearinghouse
POB 527
Cambridge MA 02139

One of the most frustrating problems facing users of applications software is the inability to use the same data with more than one program. Users often know that one program has stored data with which a second program could work wonders, but incompatible storage formats make the data inaccessible to the second program. If you own an applications program, you ought to have control over the data in that program. But rarely do you enjoy full possession of this data.

Generating graphics from stored data provides a good example of this problem. Suppose you are using a data-analysis program to project your company's profits for the years 1980 to 1982. You enter data and run calculations, and the program produces table 1. You have a plotting program that can produce striking graphics to illustrate data, but the plotting program won't accept data in the format of the data-analysis program.

The need for a standard format for data exchange has long been recognized.

In the absence of a recognized standard format for data exchange between programs, you have only three choices for making the data from the first program useful with the second. You can retype all the data, write a program to reformat all the data, or modify one of the programs to accept data in a different format.

Each of these three data-transfer processes is inefficient and tedious. In a business environment, programs for billing, invoicing, inventory, ordering, and projections may all need the same data. Transferring data among all these different programs can take a great deal of time. Clearly, if all the programs used the same data format, the problems and inefficiencies would be greatly reduced.

Although many people see the need for a standard format for data exchange, we still lack such a standard. From time to time, individual users and commercial software houses have tried to establish a standard (particularly for use with VisiCalc, the electronic worksheet program written by Software Arts Inc and distributed by Personal Software Inc), but their efforts have failed to win wide acceptance.

Software Arts is now trying to provide a standard by offering DIF, a specific format for data interchange. The DIF file format stores tables of data and provides easy access to the data by any program using DIF. Many commercially available programs already use DIF, and more are coming soon. Some of the programs now available (in addition to VisiCalc) are VisiPlot, VisiTrend/VisiPlot, and CCA Data Management System, all from Personal Software Inc; TREND-SPOTTER, from Friend Information Systems, published by Software Resources Inc; and DB

About the Authors

Candace E Kalish is a freelance writer. Malinda F Mayer is a technical writer at Software Arts Inc. Contributing writers include Dena B Feldstein, publications manager, and Patrick J Slaney, programmer, both of Software Arts Inc.

Master, from Stoneware Microcomputer Products. All versions of VisiCalc support DIF except VisiCalc 1.37 on the Apple II and VisiCalc PLUS on the HP-83/85.

The DIF Approach

DIF is easy for both beginners and advanced programmers to use and understand, yet it has sufficient power and versatility for most applications. Programs using DIF may be written in any language from BASIC to Pascal to assembly language. Furthermore, DIF is not dependent on the features of any particular computer. Because DIF avoids unusual features, data formatted in DIF can be transferred between programs regardless of the computers on which they are run.

Here are a few examples of DIF applications:

- Report generators and graphics programs can take data saved in DIF and produce easily grasped reports and vivid illustrations of what the data means.
- Programs that accept data from laboratory instruments can use DIF as a data-storage format, making the data easily accessible for later analysis by other programs.
- Periodic data stored in DIF can be consolidated later into a master report.
- If data is stored in DIF, two different types of computers can exchange the data over communications lines (such as an RS-232 connection).

The DIF Format

DIF represents data in tables and provides for optional accompanying information that describes the data. Descriptive information can be associated with all of the data in the table or with a specific column. In table 1, for instance, the title "Profit Report" clearly refers to the whole table. The labels "Year," "Sales," "Cost," and "Profit," however, each refer to only one column of data. Programs can use the data values and ignore the title and labels if desired.

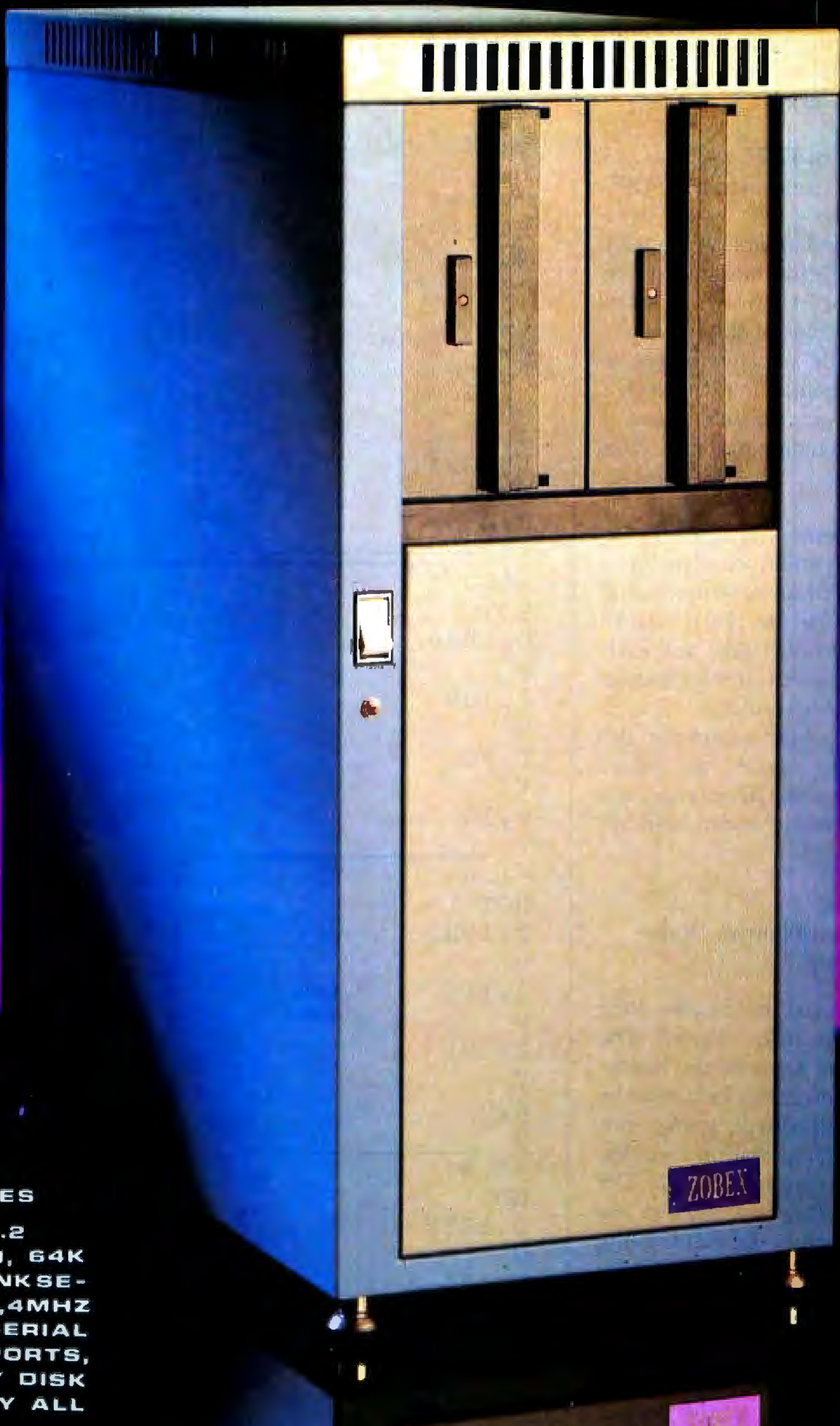
Because tables can be structured in many different ways, DIF uses the terms "vector" and "tuple" instead of "column" and "row." Each tuple in table 2 contains one data value from each vector. This example has three

PROFIT REPORT

Year	Sales	Cost	Profit
1980	100	90	10
1981	110	101	9
1982	121	110	11

Table 1: *A simple table projecting profits for the years 1980, 1981, and 1982.*

MULTIUSER



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tuples of four data values each:

1980,100,90,10
1981,110,101,9
1982,121,110,11

To keep the format simple, DIF requires that all the tuples in a table have equal length and that all the vectors have equal length.

The Structure of DIF

To illustrate the structure of DIF, we will show how DIF would store the data presented in table 1. Figure 1 shows the DIF file for the data in table 1, with large braces drawn to label various subdivisions of the file.

Every DIF file has two parts: a header section containing descriptive information about the table, and a data section containing the data values.

DIF Header Items

The header section consists of a series of header items, each describing one aspect of the file. Each header item consists of four fields, and each field contains a piece of information about the data-file format.

The fields in a header item are the topic, the vector number, the value, and the string value. DIF arranges the four fields of each header item on three lines:

Line 1 Topic
Line 2 Vector Number, Value
Line 3 "String"

Figure 2 shows the header item TABLE with the fields labeled. The topic field is the name of the header item; information in this field must be an uppercase alphabetic string with no spaces or quotation marks. TABLE is the topic in figure 2. The vector number, the first field on the second line, specifies the vector being referenced. Note, however, that if the header item does not belong to a single, specific vector, then the vector number used is 0. Since the header item TABLE refers to the entire file rather than to any single vector, TABLE's vector number is 0. The data value for the header item TABLE is the version number, and must be 1. On the third line, the string value for

```
TABLE
0,1
"PROFIT REPORT"
VECTORS
0,4
""
TUPLES          } Header Item
0,3
""
LABEL
1,0
"YEAR"
LABEL
2,0
"SALES"
LABEL
3,0
"COST"
LABEL
4,0
"PROFIT"
DATA
0,0
""              } Header Section
-1,0
BOT
0,1980
V
0,100
V
0,90
V
0,10
V
-1,0
BOT
0,1981
V
0,110           } Data Value
V
0,101
V
0,9
V               } Tuple
-1,0
BOT
0,1982
V
0,121
V
0,110
V
0,11
V
-1,0
EOD             } Data Section
```

Figure 1: *A DIF data file with the components labeled. Each of the LABEL header items labels one vector. The data is stored in tuples. "BOT" marks the beginning of each tuple, and "EOD" marks the end of the data file.*

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the header item TABLE is "PROFIT REPORT," the title of the table. In summary, the header item TABLE is organized as follows:

```
TABLE
0,version#
"title"
```

The header section in figure 1 contains other items. The header items TABLE, VECTORS, TUPLES, and DATA are required. The order of the items does not matter, as long as TABLE is first, DATA is last, and VECTORS comes before any use of vector numbers.

The next two header items specify the number of vectors and tuples in the table. The topic VECTORS refers to the entire table rather than to a single vector, so the vector number is 0. The value of the header item VECTORS is the count of vectors in the file. Since the table has four columns, the data value of item VECTORS is 4. The item VECTORS has no string value, as shown by the empty pair of quotation marks. Thus, the header item VECTORS has the following form:

```
VECTORS
0,count
""
```

Similarly, the header item TUPLES for our sample table has a vector of 0, a data value of 3, and no string value. The form of the header item TUPLES is:

```
TUPLES
0,count
""
```

Data values of the topic VECTORS and the topic TUPLES must always be integers.

Before the last required header item, DATA, DIF permits standard optional header items. Among these are LABEL (described below), COMMENT, and SIZE. DIF also permits defining new header items to meet special needs. The DIF Technical Specification (available from the DIF Clearinghouse) describes in detail all the standard header items.

Looking again at figure 1, you can see that the header items whose topic is LABEL refer to specific vectors. Each item whose topic is LABEL has a vector number and may have a data value as well. The data value of a LABEL item is the number of lines required by the label. This is how DIF provides for labels that require more than one line. Systems that allow only single-line labels can ignore the line number. Note that under DIF, the values 0 and 1 are equivalent line numbers. Each of the LABEL header items has a string value, and that string value is the label of the vector.

	TABLE	—Topic
Vector Number →	0,1	—Value
	"Profit Report"	—String

Figure 2: *The organization of a DIF header item. The first line shows the topic. The second line shows the vector number and the value. Line 3 is the character string that is the header item's title.*

	Vector 1	Vector 2	Vector 3	Vector 4
Tuple 1	1980	100	90	10
Tuple 2	1981	110	101	9
Tuple 3	1981	121	110	11

Table 2: *A recasting of table 1 into DIF format, with tuples in place of rows, and vectors in place of columns.*

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Thus, the form of the header item LABEL may be represented as:

```
LABEL
vector#,line#
"label"
```

In figure 1, vector 1 is the column labeled "YEAR," vector 2 is the column labeled "SALES," vector 3 is the column labeled "COST," and vector 4 is the column labeled "PROFIT." Each label requires only one line, and so the data value is given as 0 (it could also be 1).

The last DIF header item must be DATA. It signals to the program that all items following are data values. A program can be structured to ignore all header items until it finds the DATA header item, which has the form:

```
DATA
0,0
""
```

DIF Data Items

The form of data items differs from that of header items. DIF organizes data by tuples. Within the tuples, values are arranged according to the order of the vectors.

Each data entry consists of three fields on two lines. The first line contains two numeric values, which are respectively the type indicator and the number value. The second line contains only one value, the string value. Together the type indicator, the number value, and the string value represent one DIF data value, in the following form:

```
type indicator, number value
string value
```

The type indicator, which must be an integer, can have one of three possible values. A type-indicator value of 0 means the data is numeric and is stored in the field immediately following the type indicator. A type-indicator value of 1 means the data is a string. For string data, the number-value field is ignored and the string value is stored on the second line of the data item. Finally, a type-indicator value of −1 indicates a special data value. The number-value field is 0, and the string-value field may have one of two special values: BOT (beginning of tuple) or EOD (end of data). These are discussed further in the section on string-field values.

The Number Value. The number value may be signed (+ or −) and may contain a decimal point. One or more blanks may precede or follow the number value. If the data value contains an exponent of a power of ten, the value is followed by the letter "E" and the signed or unsigned exponent. The number value is the only place that DIF allows a noninteger value.

When the data value is numeric, the string-value field contains one of the values described in the following section.

The String Value. When the type-indicator is 1, the data is a string and contains no control characters and no quotation marks. If the string is a sim-

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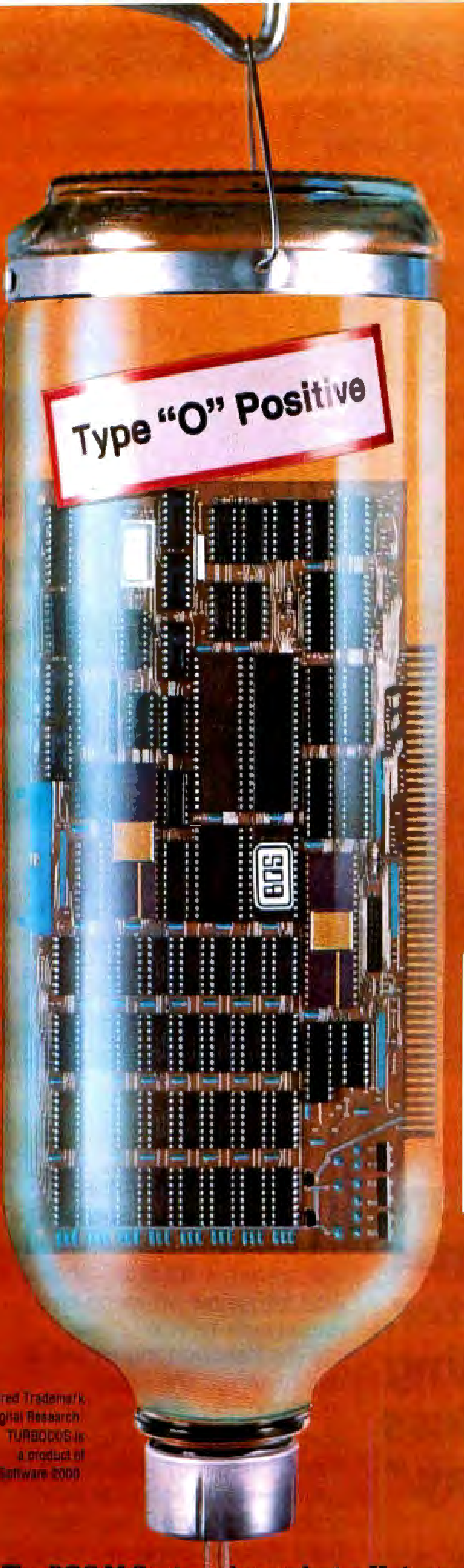

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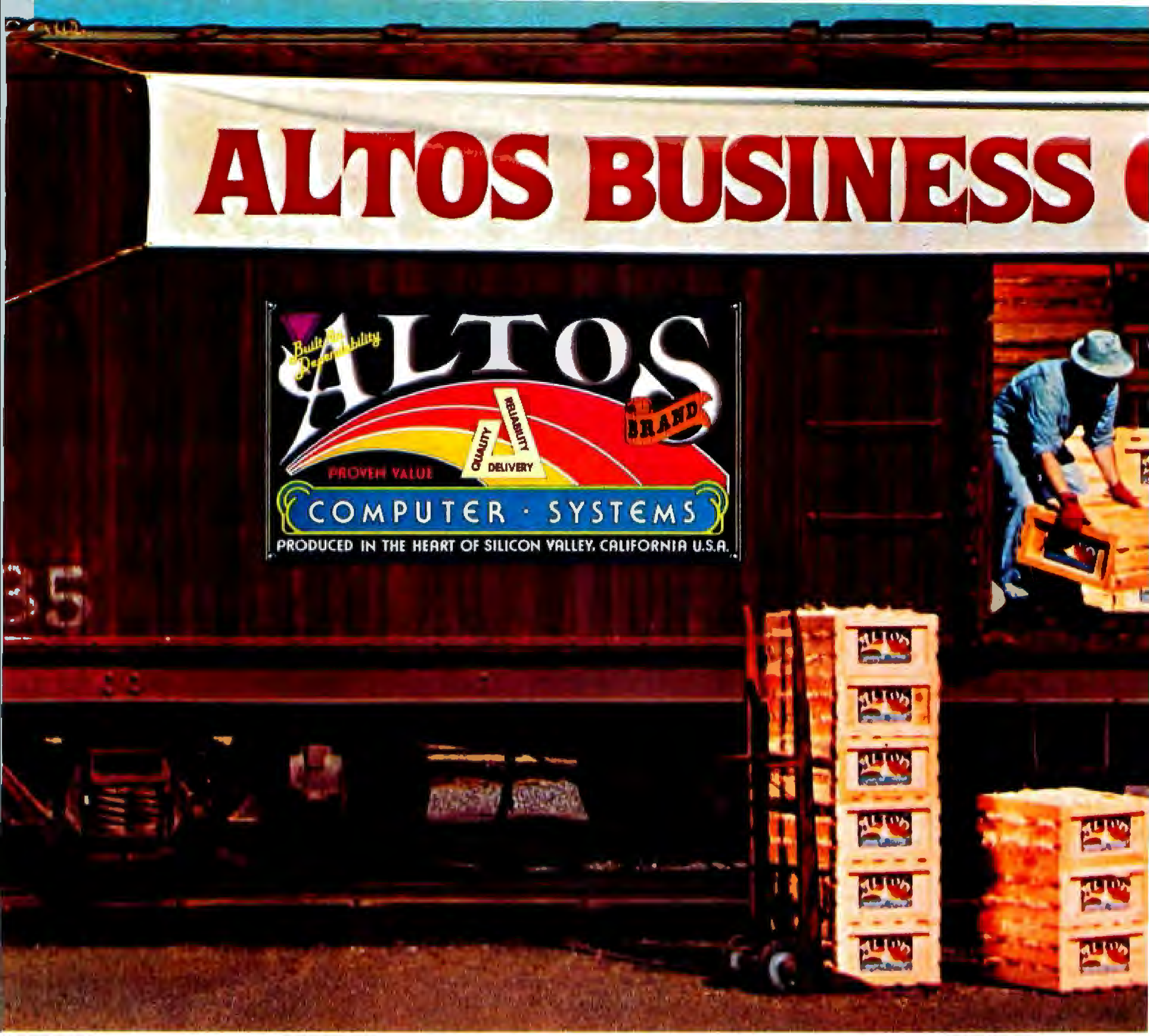

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ple word, it may be entered directly on the line. If the string contains blanks or special characters, then the string must be enclosed in quotation marks. If the string is null, the string-value field contains quotation marks with no space between them.

When data is numeric, the string value is one of the following uppercase, unquoted words:

- V: indicates a numeric value.
- NA: not available. Indicates that the value marked is not available; the number value is 0.
- ERROR: the result of an invalid calculation; the number value is 0.
- TRUE: the logical value; the number value is 1.
- FALSE: the logical value; the number value is 0.

Special Data Values. If the type-indicator field is −1, then the data is one of two special data values, BOT or EOD. BOT flags the beginning of a tuple, and EOD flags the end of the last tuple in the file.

Sample Programs Using DIF

Listings 1 and 2 are BASIC programs that illustrate the use of DIF. Listing 3 is a Pascal program that shows a Pascal procedure to use a DIF file.

A teacher has written the program in listing 1 to create a DIF file that contains the names and tests scores of students. Because it is heavily commented, the program should not be difficult to follow. It prompts the teacher to enter a file name, the number of students, and the number of test scores for the students. The program organizes the data into one tuple for each student; a tuple consists of one string value for the student name and one numeric value for each test score. The number of vectors is one more than the number of test scores per student; the extra vector is for the student's name.

For example, if three test scores are entered for a student, there are four vectors, and a typical tuple might contain the following information:

Stephenson
75
82
60

This program enters student records into a file by prompting the

Text continued on page 206

Listing 1: *A BASIC program that uses DIF. This program prompts the user for a student's name and test scores and then copies the information into a DIF file.*

```
100 REM - THIS PROGRAM CREATES A DIF FILE CONTAINING THE
110 REM - NAME AND TEST SCORES OF A GIVEN NUMBER OF STUDENTS.
120 REM - IT PROMPTS FOR A FILE NAME, THE TOTAL NUMBER OF
130 REM - STUDENTS, AND THE NUMBER OF TEST SCORES FOR
140 REM - EACH STUDENT.  IT THEN PROMPTS FOR A STUDENT'S
150 REM - NAME AND TEST SCORES, AND WRITES THEM TO THE
160 REM - FILE AS A TUPLE.


1000 PRINT "OUTPUT FILE NAME:"; :REM - GET FILE NAME.
1010 INPUT F$
1020 OPEN "O",1,F$              :REM - OPEN FILE FOR OUTPUT.
1030 PRINT "NUMBER OF STUDENTS:";
1035                            :REM - PROMPT FOR NUMBER OF
1040 INPUT NT                   :REM -    TUPLES.
1050 PRINT "NUMBER OF TEST SCORES PER STUDENT:";
1060 INPUT NV                   :REM - NUMBER OF VECTORS IS
1070 NV = NV + 1                :REM -    NUMBER OF SCORES + 1.
1080 GOSUB 3000                 :REM - USE SUBROUTINE TO
1090                            :REM -    OUTPUT DIF HEADER.
2000 FOR I = 1 TO NT            :REM - OUTPUT A TUPLE FOR
```

Listing 1 continued on page 188

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Listing 1 continued:

```
2010                              :REM -    EACH STUDENT.
2020    T = -1: V = 0: S$ = "BOT"
2025                              :REM - OUTPUT BOT SPECIAL
2030    GOSUB 4000                :REM -    DATA VALUE.
2040    PRINT "NAME OF STUDENT #";I;
2050    INPUT S$                  :REM - GET NAME OF THIS STUDENT.
2060    T = 1: V = 0              :REM - OUTPUT AS STRING DATA
2070    GOSUB 4000                :REM -    VALUE.
2080    FOR J = 1 TO NV-1         :REM - PROCESS EACH SCORE.
2090       PRINT "SCORE #";J;
2100       INPUT V                :REM - GET SCORE.
2110       T = 0: S$ = "V"        :REM - OUTPUT SCORE AS A DATA
2120       GOSUB 4000             :REM -    VALUE.
2130    NEXT J
2140 NEXT I
2150 T = -1: V = 0: S$ = "EOD"   :REM - OUTPUT EOD SPECIAL DATA
2160 GOSUB 4000                   :REM -    VALUE.
2170 CLOSE 1                      :REM - CLOSE THE OUTPUT FILE.
2180 STOP                         :REM - DONE.

3000                              :REM - ROUTINE TO OUTPUT HEADER.
3010 PRINT#1,"TABLE":PRINT#1,"0,1":GOSUB 3500
3020 PRINT#1,"TUPLES":PRINT#1,"0,";NT:GOSUB 3500
3030 PRINT#1,"VECTORS":PRINT#1,"0,";NV:GOSUB 3500
3040 PRINT#1,"DATA":PRINT#1,"0,0":GOSUB 3500

3050 RETURN
3500                              :REM - ROUTINE TO OUTPUT A
3510                              :REM -    NULL STRING ("").
3520 PRINT#1,CHR$(34);CHR$(34)    :REM - PRINT 2 QUOTATION MARKS.
3530 RETURN

4000                              :REM - ROUTINE TO OUTPUT A DATA
4010                              :REM -    VALUE.  T IS THE TYPE
4020                              :REM -    INDICATOR, V IS THE
```

Listing 1 continued on page 190

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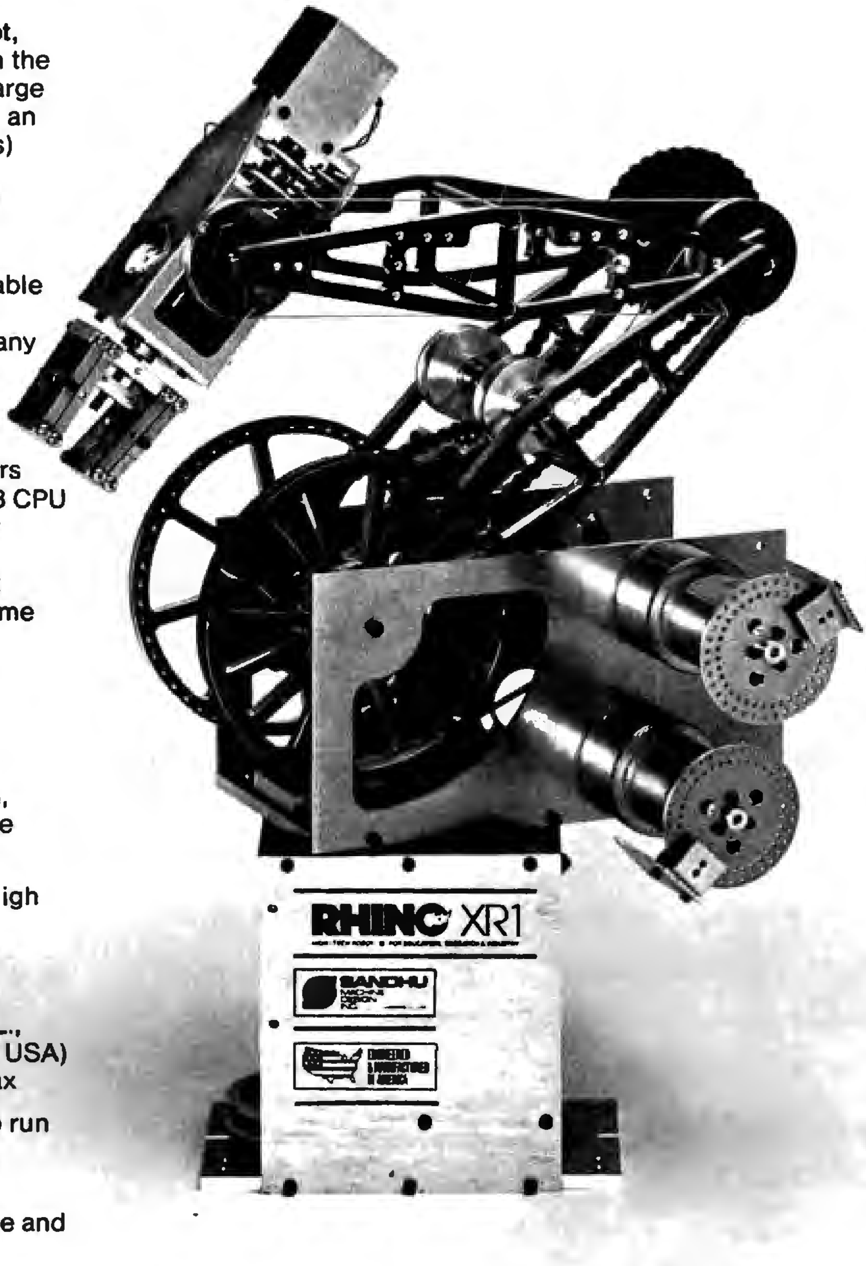

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Listing 1 continued:

```
4030                              :REM -    NUMBER VALUE, AND S$
4040                              :REM -    IS THE STRING VALUE.
4050 PRINT#1,T;",";V
4060 PRINT#1,S$
4070 RETURN
5000 END
```

Listing 2: *A BASIC program whose input is the DIF file created by the program in listing 1. This program calculates an average test score and a letter grade for each student.*

```
100   :REM - THIS PROGRAM READS A DIF FILE CONTAINING THE
110   :REM - TEST SCORES OF A GROUP OF STUDENTS, CALCULATES
120   :REM - AN AVERAGE SCORE FOR EACH STUDENT, MATCHES THE
130   :REM - AVERAGE TO A LETTER GRADE, AND PRINTS THE
140   :REM - STUDENT'S NAME, AVERAGE, AND LETTER GRADE.

500 DIM T(100)          :REM - MAXIMUM OF 100 VECTORS.
510 DIM V(100)          :REM - T IS THE TYPE INDICATOR, V IS
520 DIM V$ (100)        :REM -    THE NUMBER VALUE, AND V$ IS
530                     :REM -    THE STRING VALUE OF EACH DATA
535                     :REM -    VALUE.
540 GOSUB 5000          :REM - INITIALIZATION SUBROUTINE.
550 GOSUB 6000          :REM - SUBROUTINE TO READ HEADER.
560 FOR I = 1 TO NT     :REM - FOR EACH TUPLE,
570    GOSUB 7000       :REM -    GET ALL VECTOR ELEMENTS IN
575                     :REM -    TUPLE.
580    M=0              :REM -    M IS THE SUM OF THE SCORES.
590    FOR J = 1 TO NV  :REM -    FOR EACH VECTOR VALUE,
600       IF T(J)=1 THEN PRINT V$(J)  :REM - PRINT NAME.
610       IF T(J)=0 THEN M = M+V(J)   :REM - ADD SCORES.
620    NEXT J
630   M = M/(NV-1): PRINT M :REM - PRINT STUDENT'S AVERAGE
640   IF M<=50 THEN PRINT "THIS STUDENT'S FINAL GRADE IS F"
650   IF M<=70 AND M>50 THEN PRINT "THIS STUDENT'S FINAL GRADE IS D"
660   IF M<=85 AND M>70 THEN PRINT "THIS STUDENT'S FINAL GRADE IS C"
670   IF M<=94 AND M>85 THEN PRINT "THIS STUDENT'S FINAL GRADE IS B"
```

Listing 2 continued on page 192

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Listing 2 continued:

```
680   IF M>94 THEN PRINT "THIS STUDENT'S FINAL GRADE IS A"
690 NEXT I
700 CLOSE 2
710 PRINT "FINISHED CALCULATING GRADES"
720 STOP


5000                    :REM - INITIALIZATION CODE.
5010 PRINT "FILE NAME";
5020 INPUT F$
5030 OPEN "I",2,F$      :REM - OPEN FILE FOR INPUT.
5040 NV = 0             :REM - INITIAL VECTOR COUNT.
5050 NT = 0             :REM - INITIAL TUPLE COUNT.
5060 RETURN
6000  :REM - READ HEADER. GET NUMBER OF VECTORS AND TUPLES.
6010 INPUT#2,T$         :REM - GET TOPIC.
6020 INPUT#2,S,N        :REM - GET VECTOR NUMBER AND VALUE.
6030 INPUT#2,S$         :REM - GET STRING VALUE.
6040 IF T$="VECTORS" THEN 6500:REM - CHECK FOR KNOWN HEADER
6050 IF T$="TUPLES" THEN 6600 :REM -    ITEMS.
6060 IF T$="DATA" THEN RETURN
6065                   :REM - "DATA" ENDS HEADER.
6070 GOTO 6010         :REM - IGNORE UNKNOWN ITEMS.
6500 NV = N            :REM - NUMBER OF VECTORS.
6510 IF NV<=100 THEN 6010 :REM - CHECK FOR 100 OR LESS VECTORS.
6520 PRINT "TOO MANY VECTORS. PROGRAM CAPACITY 100 VECTORS."
6530 CLOSE 2
6540 STOP
6600 NT = N            :REM - NUMBER OF TUPLES.
6610 GOTO 6010         :REM - GET NEXT HEADER ITEM.


7000  :REM - SUBROUTINE TO GET ALL VECTOR ELEMENTS IN A TUPLE.
7010 GOSUB 8000        :REM - GET NEXT DATA VALUE.
7020 IF T1<>-1 THEN 9000 :REM - MUST BE BOT, ELSE ERROR
7030 IF S$<>"BOT" THEN 9000
```

Listing 2 continued on page 194

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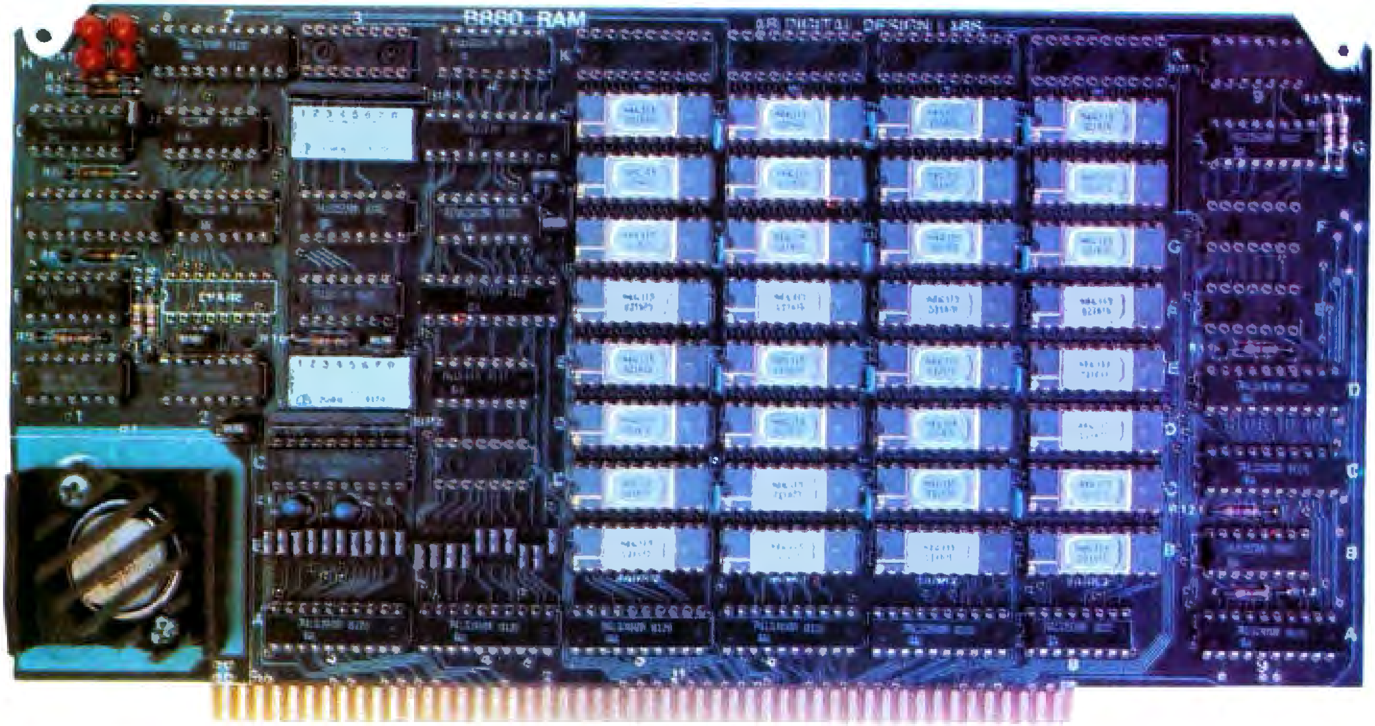

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Listing 2 continued:

```
7040   FOR K = 1 TO NV :REM - GET EACH DATA VALUE.
7050      GOSUB 8000
7060      IF T1>1 THEN 9000
7070      T(K) = T1     :REM - SAVE TYPE INDICATOR.
7080      V(K) = V1     :REM - SAVE NUMBER VALUE.
7090      V$(K) = S$    :REM - SAVE STRING VALUE.
7100      NEXT K
7110 RETURN

8000   :REM - SUBROUTINE TO GET NEXT DATA VALUE.
8010 INPUT#2,T1,V1      :REM - GET TYPE INDICATOR, NUMERIC
8020 INPUT#2,S$         :REM -    VALUE, AND STRING VALUE.
8030 RETURN

9000   :REM - ERROR ROUTINE
9010 PRINT "ERROR IN FILE FORMAT"
9020 CLOSE 2            :REM - END PROGRAM
9030 STOP
9040 END
```

Listing 3: *A Pascal program that reads data from a DIF file into an array and then displays the data on the terminal. The variant of Pascal used is Apple Pascal 1.1.*

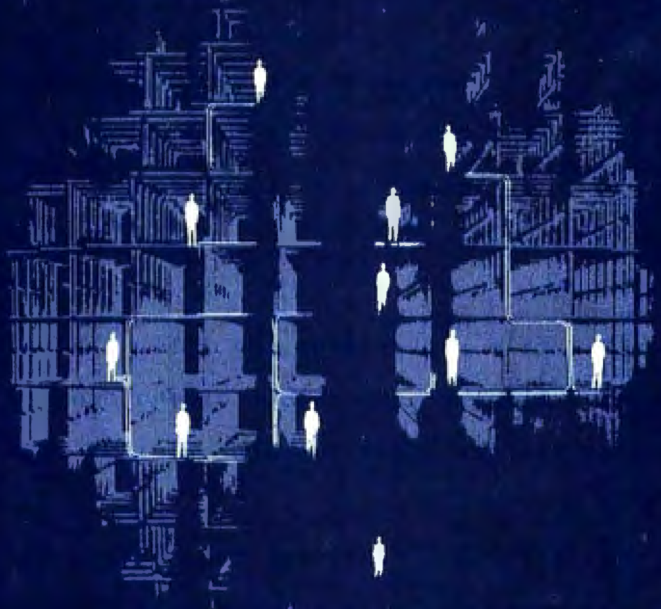
```
{ This is a simple program which reads DIF file data into an array and
  displays the results on the terminal.  It makes use of a procedure
  called "get_dif_array" which handles only numeric data.  It is written
  for Apple Pascal 1.1 and may require modification to run on other systems. }

program dif_read;

const
   max_vector =  10;                      { maximum number of vectors }
   max_tuple  =  10;                      { maximum number of tuples }

type
   vector_index = 0..max_vector;
```

Listing 3 continued on page 196



Listing 3 continued:

```
   tuple_index  = 0..max_tuple;
   dif_array    = array[1..max_vector, 1..max_tuple] of real;


var
   in_file      : text;              num_vectors : vector_index;
   fname        : string[15];        num_tuples  : tuple_index;
   matrix       : dif_array;         code, i, j  : integer;


{ "Get_dif_array" reads a DIF file and returns the file data (currently
  only numeric) in an array.  Also returns number of vectors and tuples
  -- these must be specified in file header -- and an error code. }

procedure get_dif_array (var dif_file: text; var real_array: dif_array;
                         var nvectors: vector_index; var ntuples: tuple_index;
                         var return_code: integer);

   const                                    { currently defined data types }
      special = -1; numeric =  0; char_string  =  1; other   =  2;

   type
      header_item  = record
                         topic        : string;
                         vector_num   : vector_index;
                         value        : integer;
                         string_value : string
                       end;
      data_value   = record
                         kind         : -1..2;    { currently defined data types }
                         number_value : real;
                         string_value : string
                       end;

   var
      hdr_item        : header_item;
```

Listing 3 continued on page 198

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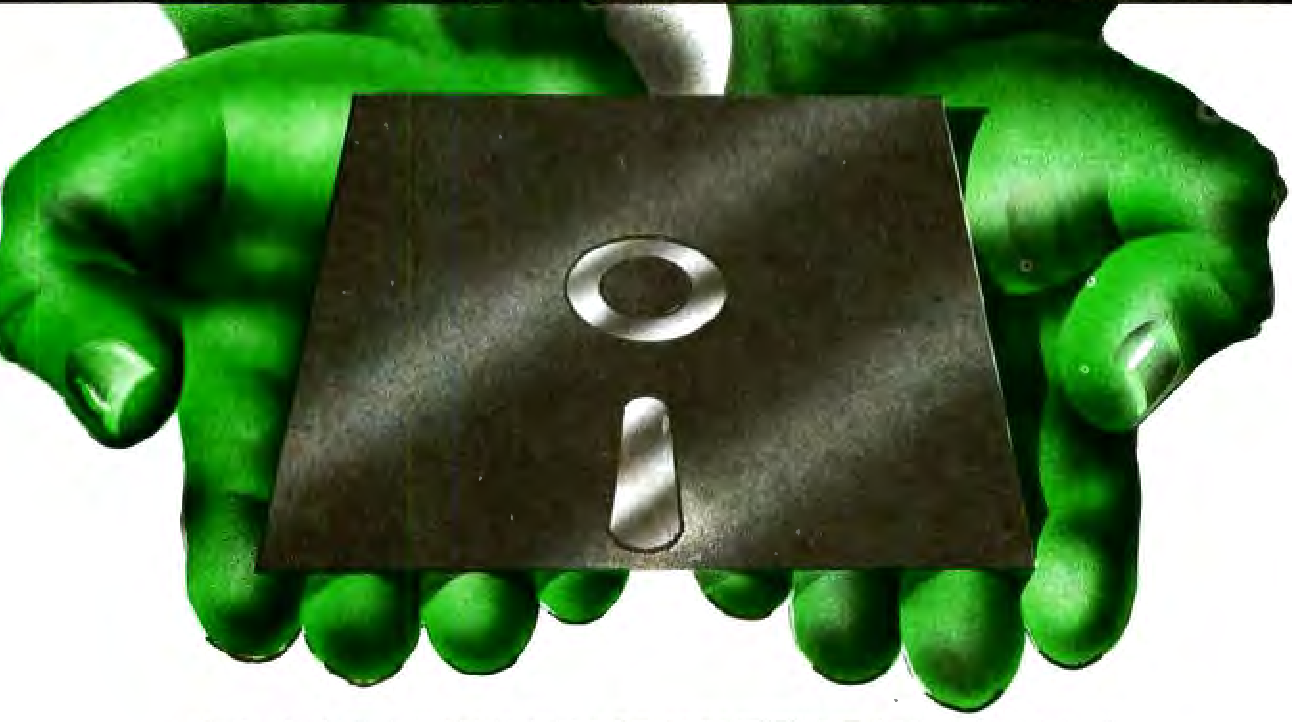

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Listing 3 continued:

```
    data_val      : data_value;
    tuple, vector : integer;


{ "Read_integer" reads an integer terminated with a comma.  The routine
  is required because this Pascal dialect´s "read" procedure recognizes
  only <space>, eoln and eof as delimiters of integer values. }


procedure read_integer (var number: integer);
   var
      sign, magnitude : integer;
      ch : char;
   begin
      sign := 1;  magnitude := 0;              { initialize }
      read (difile, ch);                       { get 1st character }
      while ch <> ´,´ do                       { comma is delimiter }
         begin
            case ch of
              ´-´ : sign := -1;
              ´0´,´1´,´2´,´3´,´4´,´5´,´6´,´7´,´8´,´9´
                  : magnitude := magnitude * 10 + ord(ch) - ord(´0´)
            end;  { case }
            read (difile, ch)                  { get next character }
         end;
      number := sign * magnitude               { return result }
   end;  { read_integer }


{ "Read_string"  deletes leading and trailing blanks and strips the
  quotes from quoted strings. }


procedure read_string (var str: string);
   begin
     readln (difile, str);
     while str[1] = ´ ´ do                               { leading blanks }
        delete (str, 1, 1);
     if str[1] = ´"´                                     { strip quotes }
```

Listing 3 continued on page 200

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Listing 3 continued:

```
        then begin
               delete (str, 1, 1);
               delete (str, pos('"', str), length(str) - pos('"', str) + 1)
             end
     else if pos(' ', str) > 0                             { trailing blanks }
        then delete (str, pos(' ', str), length(str) - pos(' ', str) + 1)
  end;  { read_string }

procedure read_header_item (var item: header_item);
  begin
     read_string (item.topic);                              { get topic }
     read_integer (item.vector_num);                        { get vector number }
     readln (difile, item.value);                           { get value }
     read_string (item.string_value)                        { get string value }
  end;   { read_header_item }

procedure read_data_value (var value: data_value);
  begin
     read_integer (value.kind);                             { get data type }
     readln (difile, value.number_value);                   { get number value }
     read_string (value.string_value)                       { get string value }
  end;   { read_data_value }

begin   { get_dif_array }
  return_code := 0;                                         { assume no problems }
  nvectors := 0; ntuples := 0;                              { initialize }
  repeat                                                    { read header }
     read_header_item (hdr_item);
     if hdr_item.topic = 'VECTORS'
        then nvectors := hdr_item.value                     { vector count }
     else if hdr_item.topic = 'TUPLES'
        then ntuples := hdr_item.value                      { tuple count }
  until hdr_item.topic = 'DATA';

  if (nvectors = 0) or (ntuples = 0)                        { check counts }
```

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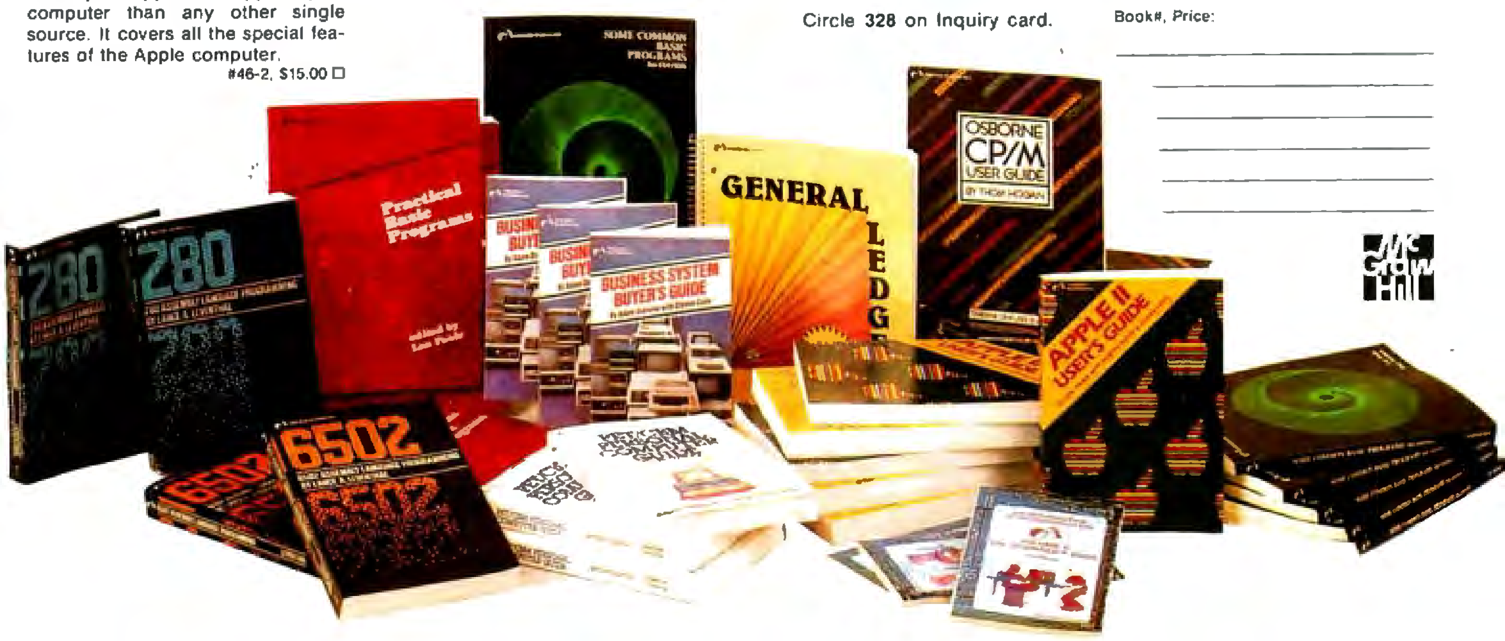

Listing 3 continued:

```
then return_code := 1

else begin

  for tuple := 1 to ntuples do                    { read data }

    begin

      read_data_value (data_val);                   { BOT }

      for vector := 1 to nvectors do

        begin

          read_data_value (data_val);

          if data_val.kind = numeric

            then real_array[vector, tuple] := data_val.number_value

        end

    end;

  read_data_value (data_val);                       { EOD }

  if (data_val.kind <> special) or

     (data_val.string_value <> 'EOD')

     then return_code := 2

  end
```

Listing 3 continued on page 204

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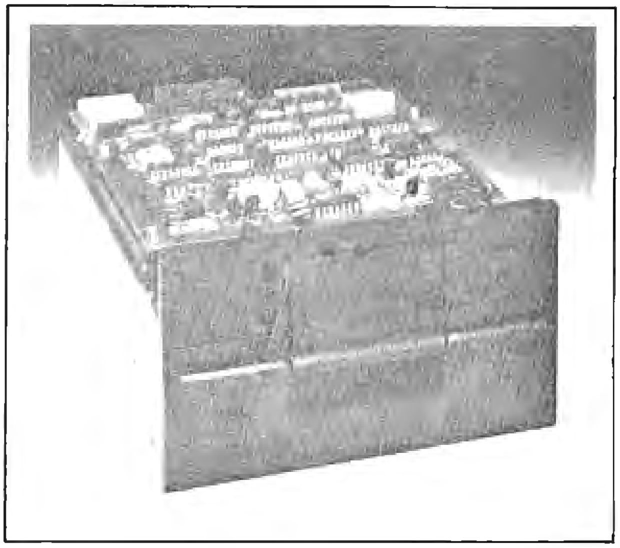

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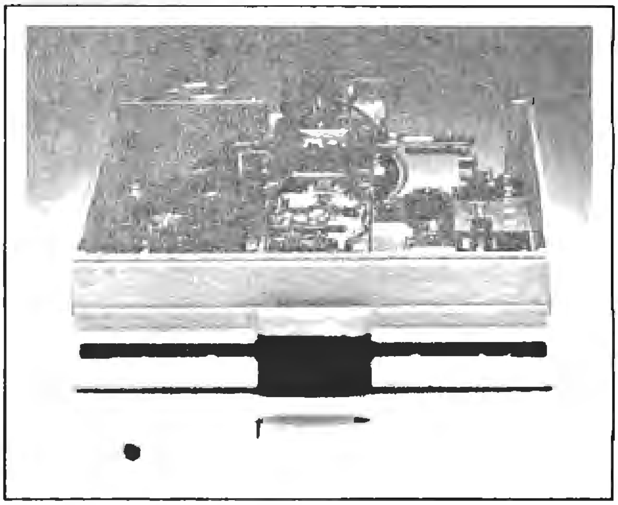

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Listing 3 continued:

```
   end;  { get_dif_array }



begin    { dif_read }

   writeln;                                          { get DIF file name }
   write ('DIF file name: ');
   readln (fname);
   reset (in_file, fname);                           { open and point to BOF }

   get_dif_array (in_file, matrix, num_vectors, num_tuples, code);

   close (in_file);                                  { close DIF file }
   case code of                                      { display results }
     0: begin
          writeln;
```

Listing 3 continued on page 206

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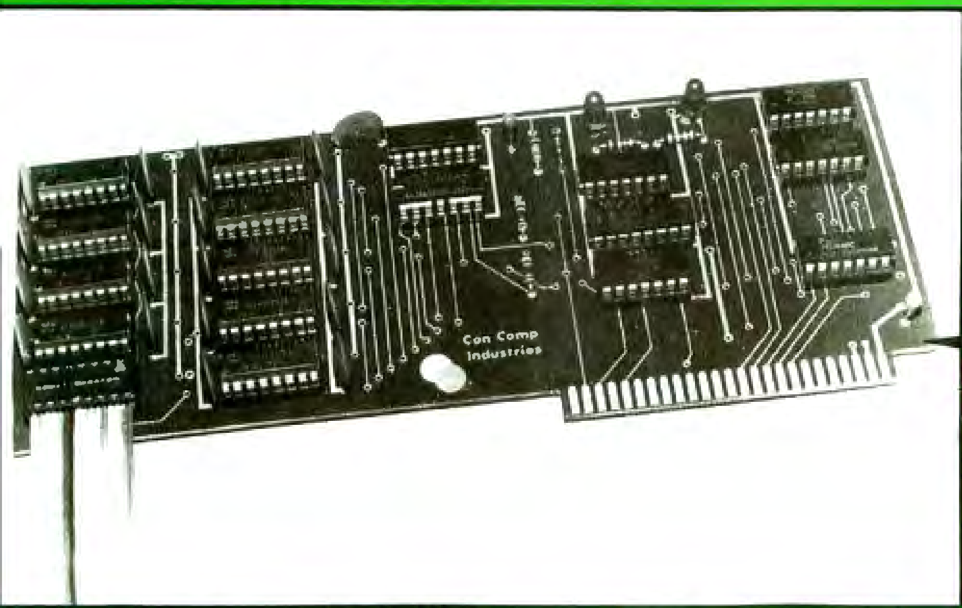

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Listing 3 continued:

```
          writeln ('"', fname:15, '"', ' contains ', num_vectors:3,
                   ' vectors and ', num_tuples:3, ' tuples.');
          writeln ('The data values follow in tuple order:');
          writeln;
          for i := 1 to num_tuples do
             begin
               for j := 1 to num_vectors do
                  write (matrix[j, i]:10:2);
               writeln
             end;
          writeln
       end;
    1: writeln ('Error. Tuple or vector count not found.');
    2: writeln ('Error. Data not properly terminated.')
    end   { case }

end.  { dif_read }
```

Text continued from page 186:

user for a student's name and test scores, and then copying the information into a DIF file.

Listing 2 takes the output DIF file from listing 1 and calculates an average score for each student and a letter grade for each student. Then the program prints the name, average, and letter grade for each student.

Listing 3, in Pascal, reads data from a DIF file into an array and displays the data on a terminal.

A close look at these listings will convince you that using DIF can simplify many programming tasks. Whatever your favorite programming language, try using the DIF format when you write your next program. You'll find the format convenient and clear, and you may make your program attractive to a large body of software users who have already stored much of their essential data in the DIF format. The accompanying text box tells you how to obtain additional information about joining the community of programmers who use DIF.■

For Further Information about DIF

The DIF Clearinghouse coordinates and distributes information about DIF and commercially available programs that use DIF. For information, send a request to the DIF Clearinghouse, POB 527, Cambridge MA 02139. Include $6.00 along with your name, address, and ZIP code.

The DIF Clearinghouse will send you the DIF Technical Specification, providing a more detailed description of the DIF format, as well as current information about programs that support DIF. The clearinghouse will also send you any updates published during the following year.

The clearinghouse would like to add to its growing list of programs that support DIF. No royalties or fees are charged for using DIF, but the clearinghouse does make three requests of authors of commercially available programs that use DIF.

First, please send a one-page description of your program to the DIF Clearinghouse. Describe what the program does, what computers it runs on, how it uses DIF, and how it can be purchased.

Second, because DIF is a trademark of Software Arts Inc, the "tm" designation must be used if DIF is mentioned in any material you publish about your program. The material also should include the statement "DIF is a trademark of Software Arts Inc."

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A Survey of Data-Base Management Systems for Microcomputers

Kathryn S Barley
DataWise
POB 426
Windermere FL 32786

James R Driscoll
Department of Computer Science
University of Central Florida
Orlando FL 32816

Advertisements for data-base management systems (DBMSs) seem more numerous all the time. At first glance, you would expect the advertised systems to perform similar functions. Yet, their prices range from $15 to $1500. What justifies such a price range? What functions do each of these systems actually perform? Some of them claim to solve almost every problem facing businesses and individuals today. Which problems *will* the available DBMSs solve? Most of the DBMSs available for large computers have principal goals of providing data integrity, data security, and data independence. Do the DBMSs available for microcomputers meet these same goals?

To answer these questions, we requested information from forty-eight companies that had advertised a DBMS for microcomputers. Our goal was not to judge systems against any preconceived DBMS standard, but rather to develop an overview of each system based on its user manual and compare all the systems feature by feature.

Eighteen companies sent us a user manual, and several included a disk of software as well. The text box on this page lists the names and addresses of these companies with the names of the products.

General Features

Table 1 lists some important general features of the twenty DBMSs, including hardware requirements, prices, available extension packages, type of data organization, method by which the user enters commands, and language in which the software is

Company	Product
Apple Orchard 131 Highland Ave Vacaville CA 95688	The Informer
Business Computer Services Co 9020 EBY Overland Park KS 66212	Data Handler
Condor POB 8310 Ann Arbor MI 48104	Condor Series 20/DBMS
Cromemco 280 Bernardo Ave Mountain View CA 94040	Cromemco Data Base Management System
Des Moines Computer 4456 Parklawn Dr Des Moines IA 50321	Micro Manager
High Technology POB 14665 Oklahoma City OK 73113	Information Master
Innovative Software 9805 Holly Kansas City MO 64114	Total Information Management —TIM
Jini Micro-Systems Inc POB 274-K Bronx NY 10463	Jinsam 2.0
Ken Knecht 6 South St, Box 68 Milford NH 03055	Dynamic Data Base
Micro AP 9827 Davona Dr San Ramon CA 94583	Selector IV
Micro Architect 96 Dothan St Arlington MA 02174	Interactive Data Manager—IDM-IV, IDM-M2
Microcomputer Technology Inc 3304 W MacArthur Santa Ana CA 92704	The Microconductor
Micro Data Base Systems, Inc POB 248 Lafayette IN 47902	MDBS
Muse 330 N Charles St Baltimore MD 21201	Micro Information System
Personal Software Inc 1330 Bordeaux Dr Sunnyvale CA 94086	CCA Data Management System
Radio Shack 700 One Tandy Ctr Ft Worth TX 76102	Profile Profile II
Systems Plus 1921 Rock St Suite 2 Mountain View CA 94043	The File Management System —FMS-80
The Bottom Shelf POB 49104 Atlanta GA 30359	Data Manager

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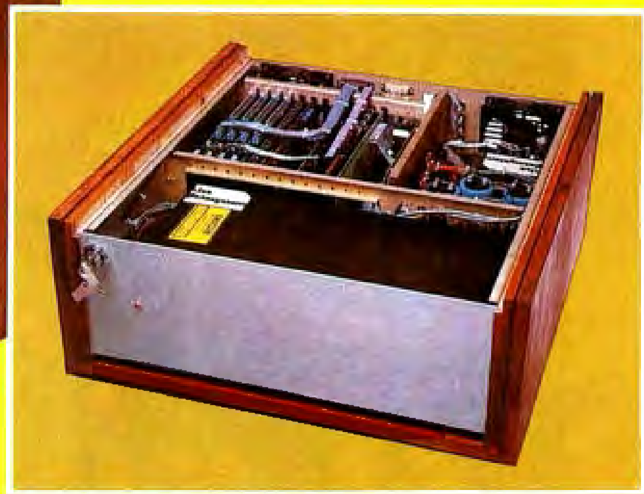

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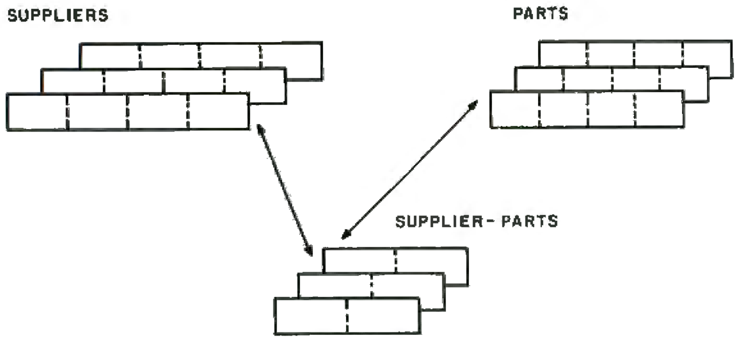

Figure 1: *A visual representation of files in a network data-base management system. The user can move through the network of files. For example, a user positioned at part number 124 in the Parts file can find out all the suppliers of that part by moving through the Supplier-Parts file to the Suppliers file.*

written. The table groups the systems by the kinds of computers on which they run, with the group that runs on the greatest number of computers listed first. With the exception of Condor and Microconductor, all the systems that cost more than $250 will in principle run on any popular small computer. However, requirements for specific hardware (for example, an 8-inch disk drive) or a specific operating system (such as CP/M) may in some cases prevent these DBMSs from running on the smallest model of some personal computers.

Most of the items in table 1 are easy to interpret, but a few require comment.

The extension packages listed in column 8 fall into three categories:

- word processors
- utility programs; for example, programs that rearrange a user's data to conform to a new definition
- statistical packages

We found no extension packages available for applications such as general ledger, inventory, or appointment scheduling, whether in the form of separate programs that use the DBMS's files or batch-command files for use within the system.

In the ninth column, headed Type, the systems that are simplest to understand are the type "file." All the records that can be used at the same time will belong to just one file, and that file constitutes the data base. For example, you might have one file that contains many records, and each of these records could consist of a supplier number, supplier name, address, and phone number.

Type "multifile" systems allow the use of more than one file. A data base of this type could include a file on suppliers, and a second file of records on parts. Each part record could contain a part number, part name, quantity on hand, and quantity on order. To indicate where each part comes from, a third file could be used as a cross-reference. Each record in this third file would contain a supplier number and part number.

A system of the type "relational"

	Runs On	5-inch Disks	8-inch Disks	Hard Disk	Maximum # Disks	Minimum Memory	Price	Extension Packages/Price	Type	Command Entry Method	Language
MDBS	1	Y	Y	Y	8	?	$900	RTL QRS/$600 DRS	Network	Type Out	Machine language
FMS-80	2	–	Y	–	16	48 K	$750	–	Multifile	Menu and Type Out	Machine language
Selector IV	2	–	Y	Y	Comb	48 K	$550	–	Multifile	Menu and Type Out	CBASIC
TIM	2	Y	Y	Y	Comb	48 K	$400	WordStar	File	Menu	Microsoft BASIC
Condor	3	Y	Y	–	4	64 K	$695	–	Relational	Type Out	Z80 Machine language
Data Handler	4	Y	–	–	2	32 K	$ 25	–	File	Menu	Applesoft BASIC Commodore BASIC
CCA	5	Y	–	–	?	32 K	$100	–	File	Menu	Machine language
Microconductor	5	Y	–	–	?	32 K	$400	–	File	Menu and Type Out	–
Information Mstr	6	Y	–	–	2	48 K	$150	Data Master/$100	File	Menu	Applesoft BASIC
The Informer	6	Y	–	–	2	16 K	$ 50	–	File	Menu	–
Micro Info Sys	6	Y	–	–	2	48 K	$100	–	File	Menu	Applesoft BASIC
Jinsam 2.0	7	Y	–	–	?	24 K	$195	Mathpack/$40 Statpack/$50 Wordpack/$50 Label Gen/$50	File	Menu	Commodore BASIC; sorts and inputting in machine language
Cromemco	8	Y	Y	–	4	64 K	$ 95	–	File	Menu	Cromemco BASIC
Micro Manager	9	–	Y	Y	Comb	48 K	$249	–	File	Menu	–
Data Manager	10	Y	–	–	4	32 K	$ 49	–	File	Menu	–
Dynamic DB	10	Y	–	–	1	32 K	$ 25	–	File	Menu	–
IDM-IV	10	Y	–	–	4	32 K	$ 69	–	File	Menu	Radio Shack BASIC; sorts in machine language
IDM-M2	10	–	Y	–	4	64 K	$199	–	File	Menu	Radio Shack BASIC; sorts in machine language
Profile	10	Y	–	–	4	16 K	$ 80	–	File	Menu	Machine language
Profile II	10	–	Y	–	4	32 K	$179	Scripsit/$300	File	Menu	Machine language

"Comb" in column 5 means support for 5-inch, 8-inch, or hard disks in combination.

1 Any with machine's DOS*
2 Any with CP/M*
3 Z80
4 Apple, PET, TRS-80
5 Apple, TRS-80
6 Apple
7 Commodore PET
8 Cromemco
9 Ohio Scientific
10 TRS-80

*Where any means any one of the following:

Cromemco	Z80
Apple	6502
TRS-80	8086
8080	North Star
8085	Zilog

Table 1: *Some general features of the twenty data-base management systems participating in the survey.*

permits a user to look at information as tables, regardless of how it is actually stored on the disk. For the suppliers and parts information, a relational DBMS could produce tables that look like the files of a multifile system. But in a relational system, these tables might be stored on disk in ways other than one file for each table. Condor, for example, keeps several files for each table. Condor is a limited relational system, but the company plans to release a version that can perform all the commands necessary to qualify as a fully relational system. The names of Condor's commands suit a business environment; for example, the command "POST" will update one table with another.

Systems of the type "network," on the other hand, let the user view the data as a network of files. The suppliers and parts information could be envisioned as shown in figure 1.

The network system allows the user to navigate through the records contained in the Suppliers file or Parts file with commands such as FIND NEXT RECORD or FIND PREVIOUS RECORD. In addition, a user positioned at a record in the Parts file where the part number is 124 could find the addresses of suppliers of that part by linking through the Supplier-Parts file to the Suppliers file. MDBS qualifies as a full network system. Its extension package, QRS, enables a user with no knowledge of the network navigational paths to query the data base with English-like commands.

The systems in the first three computer groups, types network, relational, and multifile, are the only systems that can access more than one data file at a time. This is important for tasks of the following types:

- Posting from one file to another.
- Printing a report that is made up of fields from more than one file.
- Creating one large list from several smaller ones.
- Producing a list that consists of records that meet certain criteria when those criteria are based on requirements from more than one file. For example, producing a list of the names and telephone numbers of suppliers from whom you can purchase a specific part.

According to the "Command Entry Method" column of table 1, some of the systems give the user a menu from which to choose a command, others require the user to type out commands, and a few systems let the user enter commands either way.

Features Related to Ease of Use

Software packages capable of performing amazing feats are worthless if using the software is more difficult than solving the original problem. Table 2 provides information about features that make DBMSs easier to use.

When reading the table, however, keep in mind that a few of the features are unnecessary on some of the DBMSs. One such feature is the ability to customize the DBMS for a specific terminal (column 1). If a DBMS runs only on a TRS-80 Model I, there is no need to customize the software for other terminals. In effect, the DBMS is already customized.

Most features in table 2, however, would benefit users of any system. An example is column 3, "Error Recovery." Error-trapping can prevent a system from crashing when the user tries to enter data of the wrong type. The cause of most crashes is an error the system failed to trap. The user manuals of six systems warn that certain errors in data entry will cause a system crash; six other manuals (question marks in the table) leave the issue in doubt.

But there are also six DBMSs that do provide error-trapping. Some systems provide error-recovery functions to deal with hardware failures, such as loss of power. Some systems allow the user to recapture data entered earlier. MDBS offers extensive error-trapping facilities. The manual devotes 75 pages to explaining the system's error messages.

Should the user of a particular system be a programmer? A "Y" in col-

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umn 13 of table 2 shows that the system belongs to one of the following three categories:

•Designed to be used by a programmer. Some systems assume the programmer will modify the system to suit the user's needs. Some of the smallest, least expensive systems (such as Data Handler) are of this type. Dynamic Data Base, for example, instructs the user to modify the system in order to sort.

•Does not require any knowledge of a programming language but is too difficult for a novice to understand. Microconductor and IDM-M2 fall in this category. Their user manuals contain computer jargon that would baffle anyone but a programmer.

•Designed in such a way that only a programmer can benefit from everything the system offers. FMS-80's user manual, for example, has explanations for three different levels: novice, experienced FMS-80 user, and programmer.

A "Y" in column 4, "Programming Language Interface," indicates that

	Can Customize System to Terminal	Can Customize System to Printer	Error Recovery	Programming Language Interface	Storage Transparent to User	User-Designed Screens for Data Entry	Help Command	Levels of Data Security	Sort Maintained	Ascending and Descending Order	Derived Data	Alternate Views	User Should Be Programmer	Batch Commands Available
MDBS	Y	Y	Y	Y	Y	N	N	512	Y	Y	Y	Y	Y	Y
FMS-80	Y	Y	Y	N	N	Y	Y	N	Y	Y	Y	Y	Y	Y
Selector IV	Y	Y	Y	N	Y	N	N	N	Y	Y	Y	N	Y	Y
TIM	Y	Y	Y	Y	N	N	Y	1	Y	Y	Y	N	Y	N
Condor	Y	N	Y	N	Y	Y	Y	N	N	Y	Y	Y	Y	Y
Data Handler	N	N	N	N	N	N	N	N	N	Y	N	N	Y	N
CCA	N	N	Crashes	Y	N	N	N	N	Y	Y	Y	N	Y	N
Microconductor	N	N	?	N	Y	N	Y	N	N	Y	Y	Y	Y	Y
Information Mstr	N	Y	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N
The Informer	N	N	?	N	N	Y	N	N	N	N	N	N	N	N
Micro Info Sys	N	N	?	N	Y	N	N	N	N	Y	Y	N	Y	N
Jinsam 2.0	N	Y	Y	Pkg Avail	Y	N	Y	3	Y	Y	Y	N	N	N
Cromemco	N	N	Crashes	N	Y	N	N	N	Y	N	N	N	N	N
Micro Manager	N	N	?	N	Y	N	N	1	N	Y	N	N	Y	N
Data Manager	N	Y	Crashes	N	N	N	N	1	N	N	N	N	N	N
Dynamic DB	N	N	Crashes	N	Y	N	N	N	N	N	Y	N	Y	N
IDM-IV	N	N	Crashes	N	N	Y	N	N	Y	N	N	N	Y	N
IDM-M2	N	N	Crashes	N	N	Y	N	2	Y	N	Y	N	Y	N
Profile	N	N	?	Y	N	Y	N	1	N	Y	Y	N	N	N
Profile II	N	Y	?	N	Y	Y	N	4	Y	N	Y	Y	N	N

Table 2: *Features of data-base management systems that affect ease of use. In the "Error Recovery" column, "CRASHES" indicates that the user manual said certain errors in data entry would cause the system to "hang" or "crash."*

the system allows a programming language to access the data-base files either directly or through the DBMS. For example, Profile's user manual contains several lines of code to be embedded in a BASIC program, while Jinsam offers an interface package on disk. MDBS can also be embedded in a host language such as BASIC, Pascal, or FORTRAN. This allows a program to access the DBMS with subroutine calls.

By definition, a DBMS hides its method of physical storage from the user. The storage method is said to be "transparent to the user." Some of the manuals, however, have explained how their files are set up. These systems are indicated in column 5.

A user-designed screen (column 6) makes a system both more versatile and more pleasant to use. Normally, the fields of a record are placed one below the other on the screen. But a file may contain too many fields to fit on the screen at one time, preventing the user from simultaneously viewing them all. A screen designed by the user can position fields at any location desired. Several screens can be designed for viewing a record with many fields. Profile II allows characters or lines to divide or highlight portions of the screen, and also supports reversed lettering.

A help command, shown in column 7 of table 2, is often provided by systems that require the user to enter commands, rather than choose from the choices on a menu. In response to the help command, the system produces a list of commands the user might need. Condor allows users to design the help responses. The responses can then include the names of the tables or files the user has specified.

Data security (column 8) is important if more than one person will be using the system, and if only certain persons are allowed to see some parts of the data. Security provisions range from one level of protection, which permits a data disk to be read only with the proper password, to the 512 possible levels of protection offered by MDBS.

Some systems allow alternate views of the same data. For example, a user-designed screen can suppress specific fields from view. This is useful if a clerk's job is to update personnel files, but the employer does not want the clerk to see sensitive figures such as the salaries of other employees.

MDBS assigns each user a password and also a read-access level and write-access level from 0 to 255. A record with a read-access level of 0 can be read by everyone. A read-access level of 5 prevents viewing by all but those with an access level of 5 or above.

To ensure data integrity, a system must offer protection against accidental or malicious data entry. Profile II provides protected fields in which data, even though it can be seen, cannot be changed. Profile II also offers a limited menu that allows the user to query, print, or update, but prevents creation of files or formats. Condor is the only system that can accept a range of values for the purpose of validating data entry.

All twenty systems provide a routine to sort or order the data, but column 9 of table 2 shows that only half the systems *maintain* the data in sorted order. A maintained sort assures that further entries will be inserted in their proper order.

Derived data (column 11) are data produced by operations on other data. Examples of derived data are the sum of a column, the number of records counted, etc. (Table 8c, discussed later, shows the specific derived-data functions each system provides.)

The term "batch" in the last column of table 2 may be unfamiliar to some readers, but the concept is easy to understand. Batch commands are usually offered by systems that require the use of commands rather than providing a menu of choices. Simply stated, a user can write several instructions on the screen and then have them all carried out at once—in a batch. For example, the user can write commands on the screen telling the system to read a particular file, select all records in that file in which the state is Florida, list on the printer the names and addresses found in those records, place that same list in a new file, and name the new file FLORIDA. After entering this sequence of commands, the user can take a coffee break while the computer executes the entire sequence.

Defining Data

Table 3 presents information on available methods for defining the data a file is to contain. Most of the systems, as shown in column 2, allow the user to specify the data type of a specific field. Examples of data types are numeric, date, and character. The table abbreviates data types and lists the spelled-out names at the bottom. The calculated-field type means data in the field will be automatically calculated, as specified by the user, from the contents of other fields whenever data are entered or modified in those fields. Only two systems, CCA and TIM, offer this feature. Only one sys-

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tem, FMS-80, allows data fields to vary in length.

Many of the systems require that a field be defined as a key field, and several systems allow more than one field to be used as a key field. Other systems allow sorting or searching of any field. Data Handler allows no field definition; an entire record is entered as a stream of characters. Then, to access any particular part of the record as a field, the user must give the beginning column number and a length.

Most of the systems specify a maximum number of fields allowed. This number differs significantly from MDBS's 255 to Data Manager's 10. Though the maximum allowed by IDM-IV is 20, there is also a maximum of 10 alphabetic fields and 10 numeric fields. IDM-IV would not allow, for example, 15 numeric fields. Microconductor limits its fields to 20, but then allows 20 subfields for each of the 20 fields. Many systems restrict the number of fields by the number of characters allowed per record, so the maximum number of fields in any specific file depends on the field length chosen. At the other extreme, Micro Information System always uses 22 fields.

Not surprisingly, the number of records or files allowed depends on the number of disk drives used, the size of the disks, etc.

"Definition Revision," the last column of table 3, refers to revision of field definitions such as length and type. A "Y" in this column indicates that revision is possible after data have been entered and will not cause loss of the previously entered data.

	Field Name	Field Types Defined	1 Key Field	Multi Key Fields	Maximum # Fields Allowed	Revision Allowed
MDBS	Y	Int Char Bin Real Log	Y	Y	255	Y
FMS-80	Y	A N V	Y	Y	255	Y
Selector IV	Y	A N J G K U	Y	Y	80	Y
TIM	Y	N C D $ I S	N	N	24	Y
Condor	Y	A N $ J An	N	N	127	N
Data Handler	N	–	N	N	0	N
CCA	Y	A N C	Y	Y	24	Y
Microconductor	Y	A $ % ! #	N	N	20	N
Information Mstr	Y	A N $	N	N	20	N
The Informer	Y	–	Y	Y	?	N
Micro Info Sys	Y	–	Y	N	22	?
Jinsam 2.0	Y	–	Y	Y	255	Y
Cromemco	Y	A N	N	N	25	?
Micro Manager	Y	–	Y	N	75	N
Data Manager	Y	A N	Y	Y	10	?
Dynamic DB	Y	A N	N	N	?	N
IDM-IV	Y	A N	Y	Y	20	N
IDM-M2	Y	A N	Y	N	40	N
Profile	Y	–	N	N	–	N
Profile II	Y	A N Dec	Y	Y	–	N

A Alpha
N Number
C Calculated
J or D Date
$ Dollar
V Variable
G Date
U or K Key
I Inverted
An Alphanumeric
% ! # Basic lang extension
Dec Decimal

Table 3: *Facilities for defining data fields. Systems vary widely in their provisions for defining key fields (to be used for sorting) and in the number of fields allowed. Only six systems permit revising the characteristics of a field without losing previously entered data.*

More Than One File at a Time

Systems that can access more than one file at a time usually provide the features included in table 4. With the subfile feature, the user can create a new file from an old one. An example is dividing a long mailing list into shorter lists by state. The user can also combine files or create a new file consisting of selected records from more than one old file. For example, a user might select from two files the names and addresses of widget manufacturers and place the names and addresses in a new file.

Updating Data

Table 5 shows the variations found in facilities for updating data. Some systems bar entry of some specific

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SOFTWARE HOWS

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characters as data; those characters are listed in column 1.

All systems let the user update one record at a time, but column 2 shows that only seven systems provide a method for simultaneously updating all records that meet specified criteria. Adding $5 to all records with a balance less than zero is a task that would require this multirecord capability. Data Handler has a process called "Mass Update." First, a column and length are specified as a field. Then, for each sequential record in turn, the user can enter a replacement value for that field. This is not an automatic multirecord update, however, because the user must change each record one at a time.

To speed data update and entry, TIM, Jinsam, Selector IV, Information Master, and FMS-80 permit one-key copying of data from a previous record's field.

Criteria for Selecting Records

A selection criterion is a rule against which a record can be tested to see if it qualifies for selection. The selection criterion can be simple and straightforward, such as "Part# > 124." On the other hand, the selection criterion can be complex: "Part# > 124 AND Part# < > 130 OR Part-name = widget." Relational systems usually permit the user to specify that the value in a field of one file match the value in a field of another file. Multifile systems pro-

	Subfile	Combination of Files
MDBS	Y	Y
FMS-80	Y	Y
Selector IV	Y	Y
TIM	Y	N
Condor	Y	Y
Data Handler	N	Y
CCA	N	N
Microconductor	N	N
Information Mstr	N	N
The Informer	N	N
Micro Info Sys	N	N
Jinsam 2.0	N	N
Cromemco	N	N
Micro Manager	N	N
Data Manager	N	N
Dynamic DB	N	N
IDM-IV	N	N
IDM-M2	N	N
Profile	N	N
Profile II	N	N

Table 4: *Facilities for accessing more than one file at a time. Only five systems can make a new file from part of an old file, and only five can combine old files or parts of old files to make a new file.*

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vide the latter capability with the use of batch commands.

Table 6 shows that all systems but one use selection criteria to specify conditions on at least one field. All but four systems allow a user to request that more than one field meet given criteria. Most of the systems permit a user to search for a record falling within a specified range. Most systems also allow the user to enter only a substring of the desired field value. For example, "Smi" would return "Smith " as well as "Smiley." But only six systems allow you to ask if a field contains nothing at all. This

	Characters Not Allowed in Field Data System Limitation	Updates One Record at a Time	Automatically Updates Multirecords at One Time	System Triggered Updates	Predefined Updates	Update Produces Audit Trail	Selection Criteria Used for Global Updates
MDBS		Y	Y	N	Y	Y	Y
FMS-80		Y	Y	Y	Y	Y	Y
Selector IV		Y	Y	N	Y	N	Y
TIM	,	Y	N	Y	N	N	N
Condor		Y	Y	N	Y	Y	Y
Data Handler	, ;	Y	N	N	N	N	N
CCA	,	Y	N	Y	N	N	N
Microconductor		Y	N	Y	Y	N	N
Information Mstr		Y	Y	N	N	N	Y
The Informer	, : " "	Y	N	N	N	N	N
Micro Info Sys	,.	Y	Y	N	N	N	Y
Jinsam 2.0	, : " " * shift	Y	N	N	N	N	N
Cromemco		Y	N	N	N	N	N
Micro Manager		Y	Y	N	N	N	N
Data Manager		Y	N	N	N	N	Y
Dynamic DB		Y	N	N	N	N	N
IDM-IV		Y	N	N	N	Y	N
IDM-M2		Y	N	N	N	Y	N
Profile		Y	N	N	N	N	N
Profile II		Y	N	N	N	N	N

Table 5: *Facilities for updating data. Seven systems provide a method for simultaneously updating all records that meet specified criteria (column 3).*

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facility could be used to determine which records have not been updated, to find errors, or to print only records that contain data in a particular field.

Predefined Queries

Some systems let you define a query, name it, and use it repeatedly by calling its name; table 7 shows which systems provide this facility. A

	Conditions on 1 Field	Conditions on 1+ Fields	Complex Nested Conditions	Maximum # Conditions Allowed	Multifile/Set Conditions	Range	Substring	Null Value
MDBS	Y	Y	Y	No limit	Y	Y	Y	N
FMS-80	Y	Y	Y	No limit	Y	Y	Y	Y
Selector IV	Y	Y	Y	10	Y	Y	Y	Y
TIM	Y	Y	Y	?	N	Y	Y	Y
Condor	Y	Y	N	32	Y	Y	Y	?
Data Handler	N	N	N	–	N	N	N	N
CCA	Y	Y	Y	–	N	Y	Y	N
Microconductor	Y	Y	N	–	N	N	Y	N
Information Mstr	Y	Y	Y	6	N	Y	Y	Y
The Informer	Y	Y	N	–	N	?	Y	N
Micro Info Sys	Y	Y	N	–	N	N	Y	Y
Jinsam 2.0	Y	Y	Y	# of fields	N	Y	Y	N
Cromemco	Y	Y	N	–	N	Y	N	N
Micro Manager	Y	N	N	–	N	N	Y	N
Data Manager	Y	N	N	–	N	Y	N	N
Dynamic DB	Y	Y	N	–	N	N	Y	N
IDM-IV	Y	Y	N	–	N	Y	N	N
IDM-M2	Y	Y	Y	4	N	Y	Y	N
Profile	Y	N	N	–	N	N	Y	N
Profile II	Y	Y	N	–	N	Y	Y	N

Table 6: *The kinds of criteria by which data-base management systems can select records. Most systems allow the user to search for a record that falls within a certain numerical or alphabetical range. Only four systems allow you to select from multiple files all the records that meet a set of conditions ("Multifile/Set Conditions").*

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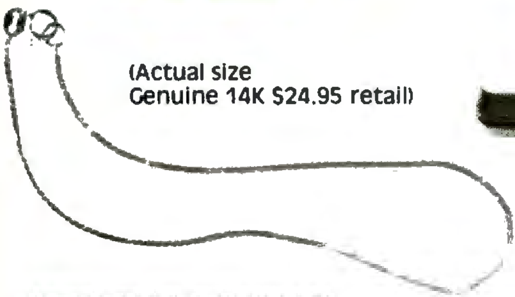

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query is usually, though not necessarily, displayed on the terminal screen, while a report is usually printed on paper with titles, etc. A predefined query thus permits periodic viewing of a list of records meeting a specific requirement, such as past due accounts, by entering all the information only the first time the query is used. A few systems limit the number of predefined queries a user can keep.

Column 3 of table 7 shows which systems allow a predefined query for which the user can enter a value at the time the query is used. That value might be the date that identifies an account as past due. Such a query could be used through the year, but with a different date each month.

Producing Reports

Reporting capabilities vary widely from system to system. In order to

	Possible	Maximum # Allowed	Modifiable When Used
MDBS	Y	–	N
FMS-80	Y	–	Y
Selector IV	Y	–	Y
TIM	Y	–	Y
Condor	Y	–	Y
Data Handler	N	–	N
CCA	N	–	N
Microconductor	N	–	N
Information Mstr	Y	15	N
The Informer	Y	–	N
Micro Info Sys	N	–	N
Jinsam 2.0	Y	–	N
Cromemco	N	–	N
Micro Manager	N	–	N
Data Manager	N	–	N
Dynamic DB	N	–	N
IDM-IV	N	–	N
IDM-M2	N	–	N
Profile	N	–	N
Profile II	Y	5	N

Table 7: *Facilities for predefined queries. It is a real convenience to be able to define and name a query, and then repeat the query without reentering its parameters.*

	Can Be Written to File	Format Predefined	Maximum # Predefined Formats	Uses Multiple Data Files
MDBS	Y	Y	?	Y
FMS-80	Y	Y	255	Y
Selector IV	N	Y	?	Y
TIM	N	Y	?	N
Condor	Y	Y	?	Y
Data Handler	Y	N	0	N
CCA	N	Y	20	N
Microconductor	Y	Y	?	N
Information Mstr	N	Y	15	N
The Informer	Y	Y	?	N
Micro Info Sys	N	Y	3	N
Jinsam 2.0	N	Y	Unlimited	N
Cromemco	N	N	0	N
Micro Manager	N	N	0	N
Data Manager	N	Y	?	N
Dynamic DB	Y	N	0	N
IDM-IV	Y	Y	10	N
IDM-M2	N	Y	10	N
Profile	N	Y	1	N
Profile II	N	Y	5	N

Table 8a: *General facilities for generating reports. Few systems can generate reports from multiple files. The ability to use predefined formats to generate reports from multiple files permits rapid production of complex reports.*

discuss the features listed in tables 8a through 8c, consider a hypothetical system having all those features. Such a system would allow a user to define a report format. The user could give the report a title, column headings, insert a paragraph of text, specify that some fields should print in ascending order, and that, within that ordering, other fields should print in descending order.

The user could set the column widths, justify the margins, print a sample record to help line up the form on a printer, specify the number of lines to skip between each record, specify a break when a certain field changes value, and then print subtotals or perform any of several statistical or mathematical functions.

	Title	Heading	Footing	Column Widths	Text Inserts	Margin Justification	Margin	Sample	# Lines Skipped Between Records	# Characters Between Records	# Records Across Page	# Lines/Record	Summary Breakpoints
MDBS	Y	Y	N	Y	N	N	Y	N	N	Y	N	N	Y
FMS-80	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
Selector IV	Y	Y	?	?	?	?	?	?	?	?	?	Y	Y
TIM	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Condor	Y	Y	N	Y	N	N	Y	N	N	N	N	Y	Y
Data Handler	N	N	N	N	N	N	N	N	N	N	N	N	N
CCA	Y	N	N	Y	N	Y	N	Y	N	N	Y	Y	Y
Microconductor	Y	Y	N	N	N	N	N	Y	N	N	N	N	Y
Information Mstr	Y	Y	N	Y	Y	N	Y	N	Y	N	N	Y	Y
The Informer	Y	Y	N	N	N	N	N	N	Y	Y	N	N	N
Micro Info Sys	N	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	N
Jinsam 2.0	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y	N	N
Cromemco	N	N	N	N	N	N	N	N	N	N	N	Y	N
Micro Manager	Y	Y	N	Y	N	N	Y	N	Y	Y	N	Y	N
Data Manager	N	Y	N	N	N	N	Y	N	N	N	N	N	N
Dynamic DB	N	N	N	N	N	N	N	N	N	N	N	N	N
IDM-IV	Y	N	N	N	N	N	N	N	N	N	N	N	N
IDM-M2	Y	N	N	N	N	N	N	N	N	N	N	N	N
Profile	Y	Y	N	Y	N	Y	N	Y	N	N	N	N	N
Profile II	Y	Y	N	N	N	N	Y	N	N	N	Y	Y	Y

Table 8b: *Facilities for formatting reports.*

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A user could even print a column for which there is no data stored. For example, the system might allow, for each record, that the second column be multiplied by the third and the result put in a new fourth column. The system might then print grand totals in yet another column.

The user could specify record numbering, choose to have footings printed on each page, and use information from several files. A user could save all these specifications in a predefined report format and use the format every month without reentering the specifications.

	Sums	Means	Minimums	Maximums	Roots	Weights	Count	Statistics	Average	User Defined	Column Resulting from Operation on 2 Columns	Record Numbering
MDBS	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	N
FMS-80	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y
Selector IV	Y	N	N	N	N	N	N	N	N	Y	Y	?
TIM	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	?
Condor	Y	N	Y	Y	N	N	N	N	Y	N	Y	N
Data Handler	N	N	N	N	N	N	N	N	N	N	N	N
CCA	Y	N	N	N	N	N	N	N	N	N	N	Y
Microconductor	Y	N	Y	Y	N	N	N	N	N	N	N	N
Information Mstr	Y	N	N	N	Y	N	N	N	N	Y	Y	Y
The Informer	N	N	N	N	N	N	N	N	N	N	N	N
Micro Info Sys	D	N	N	N	N	D	D	N	D	N	N	Y
Jinsam 2.0	(2)	(2)	(2)	(2)	(2)	(2)	Y	(2)	(2)	N	(2)	Y
Cromemco	N	N	N	N	N	N	N	N	N	N	N	N
Micro Manager	N	N	N	N	N	N	N	N	N	N	N	N
Data Manager	N	N	N	N	N	N	N	N	N	N	N	N
Dynamic DB (1)	D	D	N	N	N	N	N	N	D	N	Y	N
IDM-IV	Y	Y	N	N	N	N	Y	N	Y	Y	N	Y
IDM-M2	Y	N	N	N	N	N	Y	N	Y	Y	Y	Y
Profile	N	N	N	N	N	N	N	N	N	N	N	N
Profile II	Y	N	N	N	N	N	N	N	N	N	N	Y

(1) Not printed; displays on screen for 15 seconds
(2) Stat and Mathpack Available
D Display only (*not* printed)

Table 8c: *Facilities for deriving new data from existing records to create a report. Only MDBS and TIM can derive statistics, although Jinsam offers an extension package for statistics.*

Tables 8a through 8c show that several systems offer many of these features, but some systems offer only a few.

Some of the less expensive systems have excellent report generators. Note in the tables all the features Information Master offers. More expensive systems provide multifile report capabilities. Selector IV, for example, can report on up to 80 fields from as many as six files. TIM has its own built-in text editor that allows you to prepare form letters, checks, invoices, and the like. Profile II and Jinsam encourage the use of their word-processing packages in conjunction with their DBMSs. This combination enables the user to personalize form letters.

Conclusion

We caution the reader against basing a buying decision solely upon the information in this article. Though we have attempted to show where these DBMSs differ and what functions they perform, a report as compact as this can present only a limited amount of information.

Of course, these twenty systems do not include all software packages advertised as DBMSs. Several new packages are currently being marketed, as are upgraded versions of some of these twenty. We believe that a potential buyer, by studying these tables, can determine which features he or she considers most important and then seek a system that offers those features.

Attempts are being made to provide integrity, security, and data independence in data-base management systems for microcomputers. Even the smaller systems have provided a feature here and there that works toward these three goals. MDBS appears to have come close to achieving all three. For software as young as data-base management systems, and hardware as young as microcomputers, the achievement of Micro Data Base Systems, Inc, is impressive. ■

PDQ: A Data Manager for Beginners

Don't Reinvent the Wheel

Paul Swanson
97 Jackson St
Cambridge MA 02140

Floppy-disk drives are fantastic devices to add to a computer. They hold more information and are faster and more reliable than cassette tapes or other data-management systems. For the sophisticated personal user, they are essential, but managing the amount of data they hold presents a problem—especially if you are trying to do the programming yourself. This article presents the PDQ Key-File System, a data-management method that offers a good compromise between speed of data retrieval and ease of programming.

Basic Techniques

Fortunately, a large amount of literature is available that will allow you to select some elegantly simple data-management techniques without reinventing the wheel. The easiest way to use a floppy disk is to store data in *sequential files* (see glossary, page 260, for definitions of italicized words) and use the disk as if it were a cassette tape. With a little modification, any program that works with cassettes will work faster by using a disk, but it will not take advantage of the disk's ability to access any portion of the file almost immediately.

Random-access files are the next step toward sophisticated data storage. Using this system, you can divide your data into *records* and read any of the records in any order; it's not necessary to read through half the file to get to one record in the middle. You can modify the file by reading just one record, changing its contents, then rewriting just that one record. You leave the rest of the file alone.

After working with random-access files for awhile, you will notice some annoyances. The one real problem is that records are stored by number. In order to find a record, you must know the right number. There are, however, ways around this: some techniques *sort* the file by arranging the records in order according to the data in each record.

When all the records in the file are sorted, a *searching* technique, usually *binary search*, must still be used to find the desired record. Sorting takes an enormous amount of time, which is another drawback to the random-access method.

Out of frustration, you may "invent" a way to store the name by which you want to find a record in an array in memory, along with the number of the record. Sorting this array in memory is much faster than sorting the entire file, and it gives you an ordered index to the file, but it still takes a long time.

The Key to Managing Data

Reading about data-management techniques may lead you to try other methods, such as *direct hashing* (which is a good method, but allows no way to put the file in alphabetical order—an obvious disadvantage if the data you are managing contains people's names). The end of your search, if you are persistent and selective (see the list of recommended reading on page 262), may be the *key-file* system. This system normally requires an extra disk file (called the key file) to store the names by which you want to refer to the records (the names are called keys). The basic advantage of the key file is that it is smaller than the record file and is, therefore, faster to search through.

There are two drawbacks to using a key file. The first is that it requires two files instead of just one. The first file stores the keys and the other file stores the records. The second drawback is the same as the one involving a random-access file: there still must be some way to find the key in the key file.

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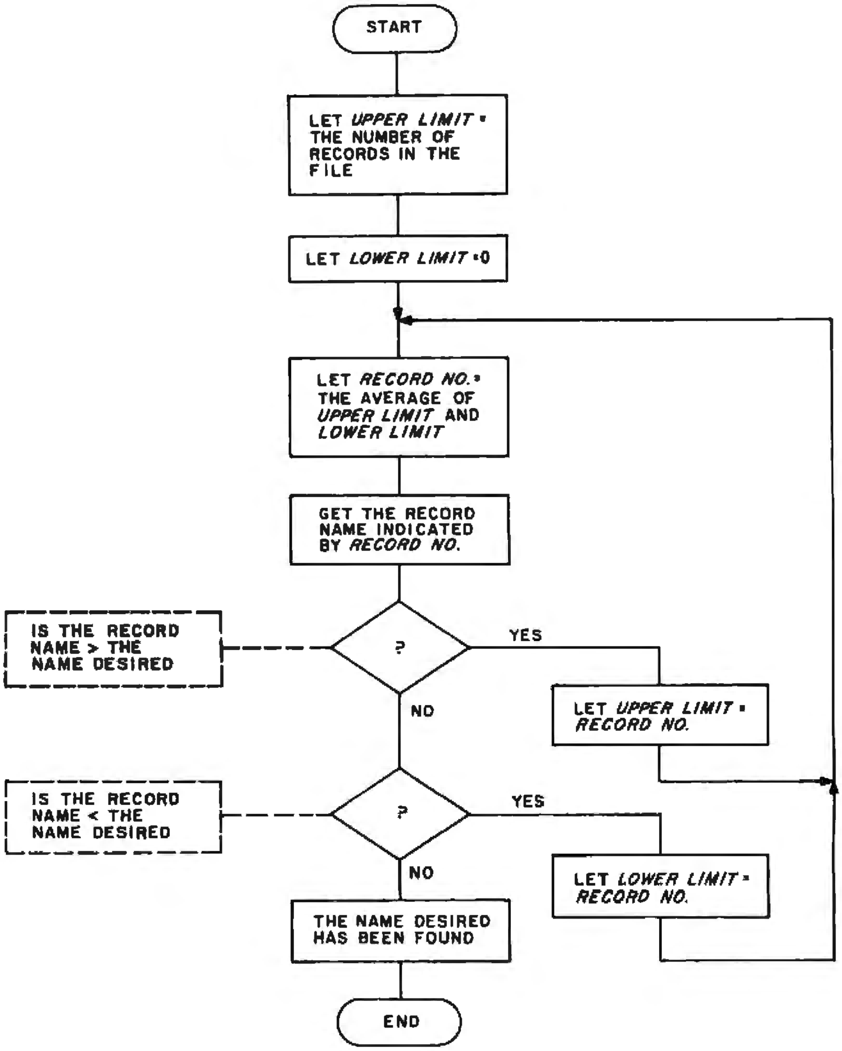
(1a)



(1b)

RECORD NUMBER	NAME	INVENTORY NUMBER	QUANTITY	SPOIL DATE
10	ZUCCHINI	10553	12000	9/21
9	POMEGRANATES	09631	353	8/17
8	PEACHES	08377	726	8/22
7	OLIVES	40163	68	8/22
6	MANGOES	80192	12	9/03
5	LETTUCE	03926	497	9/12
4	KUMQUATS	67167	521	9/21
3	GRAPES	11131	331	8/27
2	BANANAS	41791	192	9/17
1	ARTICHOKES	10767	226	9/15

Figure 1: *Conducting a binary search through a sorted file. The flowchart for the binary search is given in figure 1a. In order for this searching technique to work, it must operate on a sorted file, as shown in figure 1b. Figure 1b is a sample of the type of information needed for the produce inventory of a market. (Most files will not be this small.)*

Many different methods offer solutions to the second drawback, finding the key. One method sorts the key file. Another technique loads the key file into a large string array in memory, then sorts the string array. But that has the same speed drawbacks as sorting the record file in the first place. *Hashing* methods are also used, and they too have a drawback: there is no way to get the keys back in alphabetical order.

Another method involves saving a few of the keys in the file in alphabetical order, then using one of a variety of methods to load the file into memory in some semblance of alphabetical order.

Key-file systems generally require an enormous amount of programming. I have one, which I use often, that takes four or five pages, depending on the version, to list. For most applications on microcomputers, this much code is not necessary.

The PDQ Key-File System does not require an extra file for the keys. It stores all of the keys, and information required for finding them, on disk, with the records in the record file. It is also shorter to program than other key-file systems. Listing the fundamental routines requires less than two pages. The system is slower than a good separate key-file program, but it is fast enough for applications that require hundreds of records (as opposed to thousands of records).

Basic Binary Search

The PDQ method is loosely based on the same principles used in the binary search. (Binary searching requires a sorted file, but this file will not be sorted.) To understand how the PDQ system works, see the binary search example of a supermarket produce inventory shown in figure 1. Locating a record in a sorted file using the binary search involves dividing ranges of records in half. Using the flowchart of the binary-search algorithm, let's try searching through a file of 10 records for the record named "peaches."

Set the *upper limit* to 11 (10 plus 1). Set the *lower limit* to zero. The variable *record no.* is the average of *upper limit* and *lower limit* (6 for the

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first pass, if you round up). Load this record, "mangoes," into memory. "Mangoes" is not greater than "peaches," it is less; so we set the *lower limit* to 6 and loop back to recalculate *record no.*, but with the limits 6 and 11.

This is how the binary-search method divides the file in half. The number of records to search through has been narrowed down to about five, instead of the 10 we started with. The next loop will look at the record whose number is 9 (the average of the new limits). When this record's name, "pomegranates," is compared with "peaches," the limits will become 6 and 9. This process of dividing the number of records to search continues until "peaches" is found, or until there are no more records to search (ie: *upper limit* is equal to *lower limit* plus one), which means that the record is not in the file.

PDQ Key-File System

As I have mentioned, the PDQ Key-File System uses a modified version of binary searching based on a tree structure (see figure 2). Each record is stored with the key (the name) and two *pointers* that are used in searching: the *greater than* pointer and the *less than* pointer.

Using the same produce-inventory example, the first record in the file is the first one entered, "lettuce." It is simply recorded with each of the two pointers set to zero. When the second record, "olives," is entered, it is necessary to compare its name to that of the first record ("olives" is greater than "lettuce"). The second record is placed in the next available storage space, and the *greater than* pointer in the first record will be set to two. In this way, record one is said to *point to* record two, to indicate that the name of record two is greater than the name of record one. Searching this tree is as simple as following the pointers (see the flowchart in figure 2a).

Unless the keys are entered in a random order, the tree will look lopsided; there is no easy solution to this, but it is not much of a drawback. The system will work most quickly when the tree is perfectly symmetrical. In that form, the system will step through exactly the same keys as it would if it were the sorted file of figure 1b, and the binary search were used. A very lopsided tree will still work, but it will be slower than a symmetrical one. When using the system, don't enter the records in alaphabetical order or the system will search the entire file sequentially. A random order is best.

A Closer Look at the System

The PDQ key-file system (see listing 1) uses an array to define such things as the record length, the key length, etc (see the REM statements on lines 40 through 110 and the DATA statement on line 160, which contains the values for the array in the indicated order). The logic of the key-file system is entirely within the subroutines starting at line 5000. The rest of the listing (lines 200 through 2010) contains a sample application.

The first subroutine gets the number of the next available record in the file. This is done using a counter that occupies record number

Text continued on page 252

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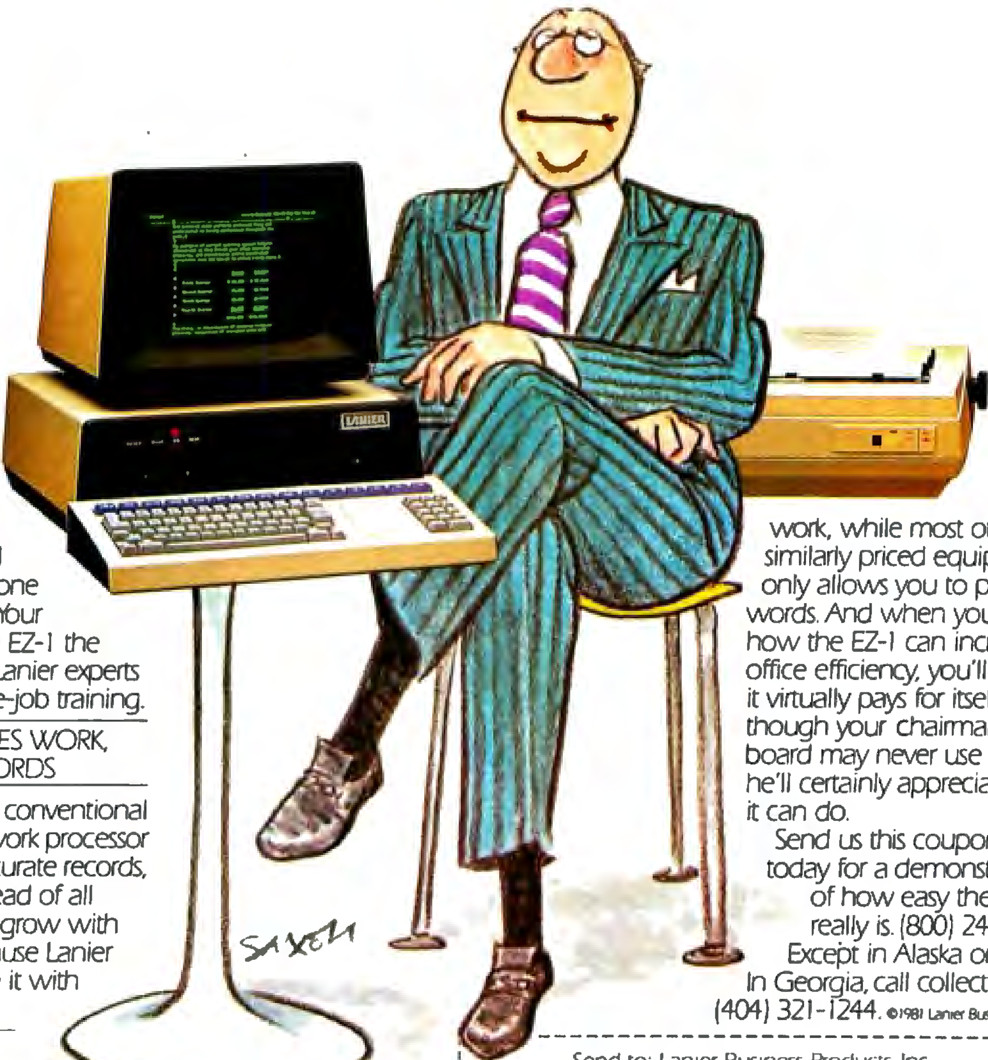

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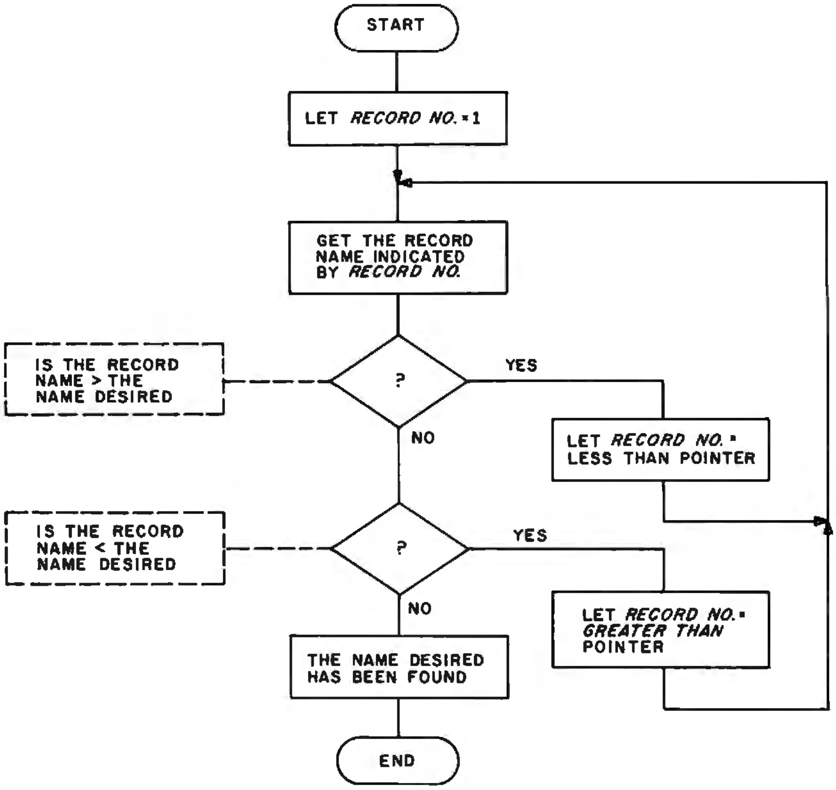

(2b)

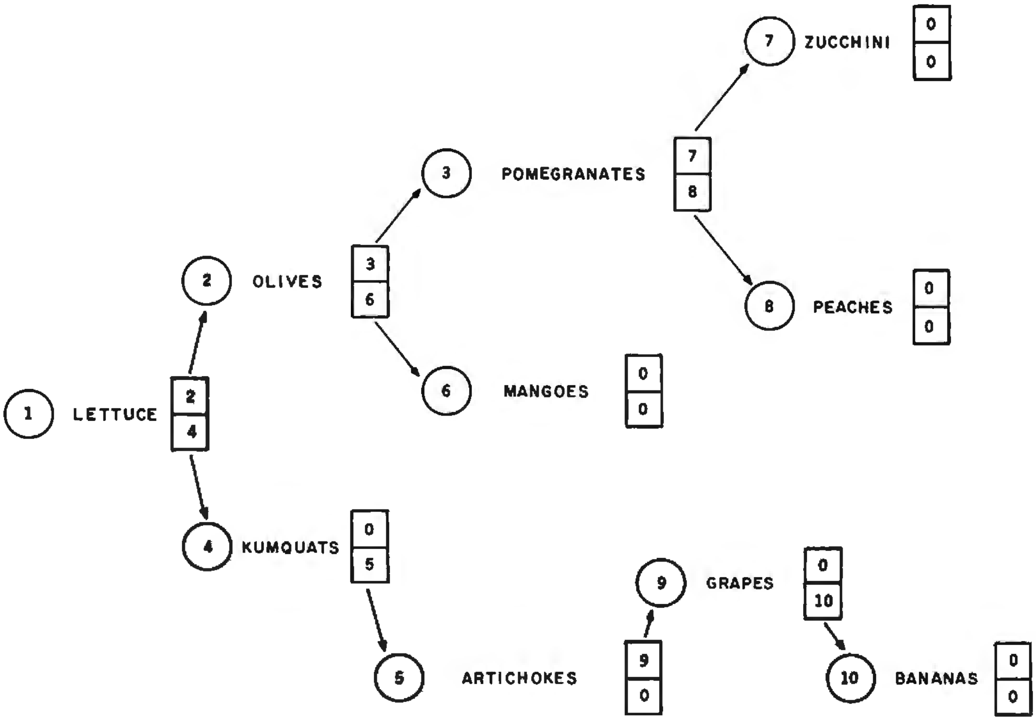

Figure 2: *Traversing the PDQ tree. Figure 2a is the flowchart for a method of searching a tree. Note its simplicity when compared to the binary-search method of figure 1a; searching the tree requires fewer steps and calculations. A sample PDQ tree (of the same data used in figure 1b) is shown in figure 2b.*

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Listing 1: *The PDQ Key-File System for the Radio Shack TRS-80 Model III. This program both creates and searches the PDQ tree for files of moderate length. The program should be easily portable for any computer using a form of Microsoft BASIC.*

```
P SWANSON   -   PDQ KEY FILE SYSTEM


      ---- SAMPLE INVENTORY PROGRAM USING KEY FILE SYSTEM ----

10 CLEAR 3000
15 DIMCA(6)
20 OPEN"R",1,"NEWFILE:0":   '*** NEWFILE = NAME OF FILE ***
30 FIELD1,255ASB$
40 REM ********* PARAMETER ARRAY **********
50 REM *****  1 # RECORDS/BLOCK ***********
60 REM *****  2 RECORD LENGTH *************
70 REM *****  3 FIRST BYTE OF GR **********
80 REM *****  4 FIRST BYTE OF LR **********
90 REM *****  5 KEY LENGTH ****************
100 REM*****  6 # RECORDS IN FILE (MAX) ***
110 REM***********************************
120 RESTORE
130 FORI=1TO6
140 READCA(I)
150 NEXTI
160 DATA 8,30,6,8,5,199
199 REM**** 200 SELECTOR ****
200 CLS
210 PRINT"              ** INVENTORY PROGRAM **"
220 PRINT
230 PRINT"  1. ADD A RECORD TO THE FILE"
240 PRINT"  2. EDIT A RECORD ON FILE"
250 PRINT"  3. PRINT FILE DUMP"
260 PRINT
270 INPUT" ENTER NUMBER OF YOUR SELECTION";N
280 IFN=27THEN400
290 ONNGOTO600,900,1400
300 GOTO270
399 REM**** 400 INITIALIZE FILES ****
400 CLS
410 PRINT"*************FILE INITIALIZATION**********"
420 PRINT
430 PRINT"ENTER PASSWORD:";
440 P$=""
445 CC=0
450 Q$=INKEY$:IFQ$=""THEN450
460 IFQ$=CHR$(13)THEN500
470 PRINT"X";
480 P$=P$+Q$
490 GOTO450
500 IFP$="SECRET"THEN510:ELSE200
510 B1$=STRING$(255,32)
520 FORI=1TO25
530 LSETB$=B1$
540 PUT1,I
550 NEXTI
560 MID$(B1$,1,2)=MKI$(0)
570 LSETB$=B1$
580 PUT1,1
590 GOTO200
599 REM**** 600 ADD A RECORD TO THE FILE ***
600 CLS
610 PRINT"              ** ADD A RECORD TO THE FILE **"
620 PRINT
630 INPUT"ITEM NUMBER";I$
640 A$=I$
650 GOSUB7000
```

Listing 1 continued on page 246

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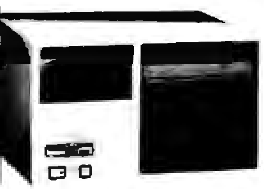

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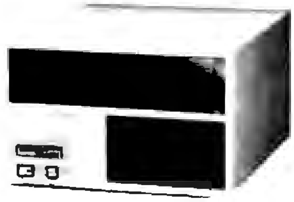

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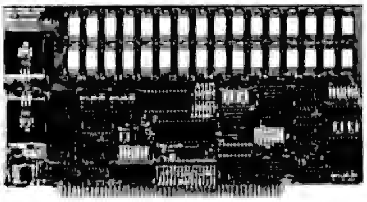

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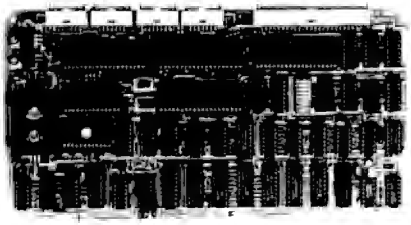

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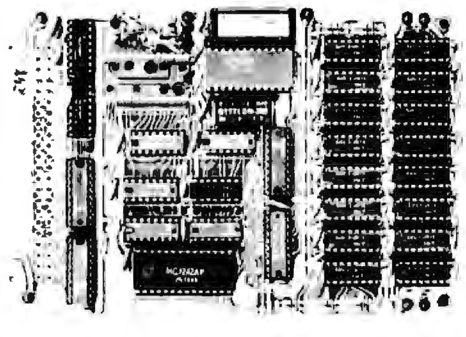

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Listing 1 continued:

```
660 IFE=0THENPRINT"DUPLICATE - KEY ALREADY IN FILE":GOTO2000
670 INPUT"DESCRIPTION";D$
680 INPUT"QUANTITY IN STOCK";Q
690 INPUT"UNIT PRICE";P
700 INPUT"ARE ALL VALUES CORRECT (Y/N)";Q$
710 IFQ$="N"THEN600
720 IFQ$<>"Y"THEN700
730 PRINT"***** SAVING RECORD IN THE FILE *****"
740 A$=STRING$(CA(2),32)
750 MID$(A$,1,5)=I$
760 MID$(A$,10,14)=D$+STRING$(14,32)
770 MID$(A$,24,2)=MKI$(Q)
780 MID$(A$,26,4)=MKS$(P)
790 GOSUB6000
800 GOTO200
899 REM**** 900 EDIT A RECORD ON FILE ****
900 CLS
910 PRINT"                ** EDIT RECORDS ON FILE **"
920 PRINT
930 INPUT"ENTER ITEM NUMBER OR END";I$
940 IFI$="END"THEN200
950 A$=I$
960 GOSUB7000
970 IFE=0THEN1000
980 PRINT"ITEM NOT IN FILE"
990 GOTO930
1000 I$=LEFT$(A1$,5)
1010 D$=MID$(A1$,10,14)
1020 Q=CVI(MID$(A1$,24,2))
1030 P=CVS(MID$(A1$,26,4))
1040 CLS
1050 PRINT"***** EDITING ITEM NUMBER ";I$
1060 PRINT
1070 PRINT"ENTER";TAB(15);"TO CHANGE";TAB(40);"CURRENT VALUE"
1080 PRINT"  -1";TAB(15);"TO QUIT AND NOT POST CHANGES"
1090 PRINT"   0";TAB(15);"TO END AND SAVE CHANGES"
1100 PRINT"   1";TAB(15);"DESCRIPTION";TAB(40);D$
1110 PRINT"   2";TAB(15);"QUANTITY";TAB(40);Q
1120 PRINT"   3";TAB(15);"UNIT PRICE";TAB(40);:PRINTUSING"####.##";P
1130 PRINT
1140 INPUT" ENTER NUMBER OF YOUR CHOICE FROM ABOVE LIST";N
1150 ONN+2GOTO900,1160,1290,1310,1330
1155 GOTO1140
1160 A$=STRING$(CA(2),32)
1170 MID$(A$,1,5)=I$+STRING$(5,32)
1180 MID$(A$,6,2)=MKI$(GR)
1190 MID$(A$,8,2)=MKI$(LR)
1200 MID$(A$,10,14)=D$+STRING$(14,32)
1210 MID$(A$,24,2)=MKI$(Q)
1220 MID$(A$,26,4)=MKS$(P)
1230 GOSUB5500
1240 B1$=B$
1250 MID$(B1$,CA(2)*(RN-1)+1,CA(2))=A$
1260 LSETB$=B1$
1270 PUT1,BN
1280 GOTO900
1290 INPUT"NEW DESCRIPTION";D$
1300 GOTO1040
1310 INPUT"NEW QUANTITY";Q
1320 GOTO1040
1330 INPUT"NEW UNIT PRICE";P
1340 GOTO1040
1399 REM**** 1400 PRINT INVENTORY LISTING ****
1400 CLS
1410 PRINT"                ** INVENTORY LISTING **"
1420 PRINT
```

Listing 1 continued on page 248

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Listing 1 continued:

```
1430 INPUT"START AT ITEM";SI$
1440 INPUT"END AT ITEM";EI$
1450 IFSI$>EI$THEN1430
1452 SI$=SI$+STRING$(5,32)
1454 EI$=EI$+STRING$(5,32)
1460 IFSI$>STRING$(5,32)THENMID$(SI$,5,1)=CHR$(ASC(MID$(SI$,5,1))-1)
1470 L9=55:P9=0
1475 TV#=0
1480 A$=SI$
1490 GOSUB8000
1500 IFE<>0THEN1690
1510 IFLEFT$(A1$,5)>LEFT$(EI$,5)THEN1690
1520 L9=L9+1
1530 IFL9<55THEN1590
1540 IFP9<>0THENFORI=L9TO65:LPRINT" ":NEXTI
1550 P9=P9+1
1560 LPRINT"                    INVENTORY LISTING REPORT              PAGE";P9
1570 LPRINT" "
1575 LPRINT"ITEM NO.";TAB(10);"DESCRIPTION";TAB(30);"QUANTITY";TAB(45);"UNIT PRI
CE";TAB(60);"EXT. VALUE"
1580 L9=4
1590 Q=CVI(MID$(A1$,24,2))
1600 P=CVS(MID$(A1$,26,4))
1610 LPRINTLEFT$(A1$,5);TAB(10);MID$(A1$,10,14);TAB(30);
1620 LPRINTUSING"#####";Q;:LPRINTTAB(45);
1630 LPRINTUSING"####.##";P;:LPRINTTAB(60);
1640 EV#=Q*P
1650 TV#=TV#+EV#
1660 LPRINTUSING"#,###,###.##";EV#
1670 A$=A1$
1680 GOTO1490
1690 LPRINT" "
1700 LPRINT"TOTAL VALUE OF INVENTORY =";
1710 LPRINTUSING"#,###,###.##";TV#
1720 GOTO200
2000 INPUT"PRESS ENTER WHEN FINISHED VIEWING";Q$
2010 GOTO200
4998 STOP
4999 REM**** GET NEXT FREE RECORD - FR ****
5000 GET1,1
5010 FR=CVI(LEFT$(B$,2))+1:        '--- Record 0, bytes 1 & 2 ---
5020 B1$=B$:                       '--- contain the count of  ---
5030 MID$(B1$,1,2)=MKI$(FR):       '--- records used.  FR is  ---
5035 LSETB$=B1$:                   '--- next available rec. # ---
5040 PUT1,1
5050 RETURN
5499 REM**** 5500 GET RECORD #RR - A1$ ****
5500 BN=INT(RR/CA(1)):             '--- BN = block no.        ---
5510 RN=RR-BN*CA(1)+1:             '--- RN = reference on block--
5520 BN=BN+1
5530 GET1,BN
5540 A1$=MID$(B$,CA(2)*(RN-1)+1,CA(2))
5560 GR=CVI(MID$(A1$,CA(3),2)):    '--- GR = greater reference---
5570 LR=CVI(MID$(A1$,CA(4),2)):    '--- LR = lesser reference ---
5580 RETURN
5999 REM**** 6000 PUT RECORD A$ INTO FILE ****
6000 GOSUB5000:                    '--- Get next free record  ---
6010 IFFR>1THEN6100:               '--- The first record gets ---
6015 A1$=A$+STRING$(CA(2),32):     '--- special treatement.   ---
6020 A$=LEFT$(A1$,CA(2)):          '--- Pack A$...            ---
6022 MID$(A$,CA(3),2)=MKI$(0)
6024 MID$(A$,CA(4),2)=MKI$(0)
6030 RR=FR:                        '--- Set record number (=1)---
6040 GOSUB5500:                    '--- Get record.           ---
6050 B1$=B$
6060 MID$(B1$,CA(2)*(RN-1)+1,CA(2))=A$
```

Listing 1 continued on page 250

Listing 1 continued:

```
6070 LSETB$=B1$:                      '--- Insert new record,      ---
6080 PUT1,1:                          '--- & put it in the file.  ---
6090 E=0:RETURN
6100 RR=1:                            '--- Start search with # 1.---
6102 IFFR<=CA(6)THEN6110:             '--- Check for end of file.---
6104 E=2:RETURN
6110 GOSUB5500:                       '--- Get record no. RR      ---
6120 IFLEFT$(A$,CA(5))<LEFT$(A1$,CA(5))THEN6200
6130 IFLEFT$(A$,CA(5))>LEFT$(A1$,CA(5))THEN6300
6140 E=1:                             '--- Equal - duplicate key ---
6142 GET1,1:                          '--- Restore original value---
6144 B1$=B$:                          '--- of record counter      ---
6146 MID$(B1$,1,2)=MKI$(FR-1)
6148 LSET B$=B1$
6150 PUT1,1
6152 RETURN
6200 IFLR=0THEN6240:                  '--- Branch if no more recs---
6210 RR=LR:                           '--- RR= next to search     ---
6220 GOTO6110:                        '--- Continue searching.    ---
6240 MID$(A1$,CA(4),2)=MKI$(FR):      '--- Spot found - pack loc.---
6250 B1$=B$
6260 MID$(B1$,CA(2)*(RN-1)+1,CA(2))=A1$
6270 LSETB$=B1$
6280 PUT1,BN:                         '--- Save pointer record    ---
6290 GOTO6400
6300 IFGR=0THEN6340:                  '--- Branch if no more recs---
6310 RR=GR:                           '--- RR= next to search     ---
6320 GOTO6110:                        '--- Continue searching.    ---
6340 MID$(A1$,CA(3),2)=MKI$(FR):      '--- Spot found - pack loc.---
6350 B1$=B$
6360 MID$(B1$,CA(2)*(RN-1)+1,CA(2))=A1$
6370 LSETB$=B1$
6380 PUT1,BN:                         '--- Save pointer record    ---
6400 RR=FR:                           '--- RR now=new record no. ---
6420 GOSUB5500:                       '--- Load record space...   ---
6430 A$=A$+STRING$(CA(2),32):         '--- Init.& pack new record---
6440 A1$=LEFT$(A$,CA(2))
6442 MID$(A1$,CA(3),2)=MKI$(0)
6444 MID$(A1$,CA(4),2)=MKI$(0)
6450 B1$=B$
6460 MID$(B1$,CA(2)*(RN-1)+1,CA(2))=A1$
6470 LSETB$=B1$
6480 PUT1,BN:                         '--- and save it on disk.   ---
6490 E=0:RETURN
6999 REM**** 7000 GET RECORD A$ FROM FILE ****
7000 RR=1:                            '--- Start with first rec. ---
7010 GOSUB5500:                       '--- Get record from file   ---
7020 IFLEFT$(A$,CA(5))<LEFT$(A1$,CA(5))THEN7100
7030 IFLEFT$(A$,CA(5))>LEFT$(A1$,CA(5))THEN7200
7040 E=0:                             '--- Equal - record found   ---
7050 RETURN
7100 IFLR=0THENE=1:RETURN:            '--- Not found              ---
7110 RR=LR:                           '--- Cont. search at # LR   ---
7120 GOTO7010
7200 IFGR=0THENE=1:RETURN:            '--- Not found              ---
7210 RR=GR:                           '--- Cont. search at # GR   ---
7220 GOTO7010
7999 REM**** 8000 GET NEXT GREATER KEY ****
8000 A$=A$+STRING$(CA(2),32):         '--- Incr. last byte of key ---
8005 MID$(A$,CA(5),1)=CHR$(ASC(MID$(A$,CA(5),1))+1)
8010 A2$=STRING$(CA(5),255):          '--- Initialize indicator   ---
8020 RR=1:                            '--- Begin search at no. 1  ---
8030 GOSUB5500:                       '--- Get record & compare   ---
8040 IFLEFT$(A$,CA(5))<LEFT$(A1$,CA(5))THEN8100
8050 IFLEFT$(A$,CA(5))>LEFT$(A1$,CA(5))THEN8200
8060 E=0:                             '--- Found directly.
```

Listing 1 continued on page 252

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Listing 1 continued:

```
8070 RETURN
8100 IFLEFT$(A1$,CA(5))<LEFT$(A2$,CA(5))THENA2$=A1$
8110 IFLR>0THEN8150:                 '--- Check for end of search--
8120 A1$=A2$:                        '--- A2$ holds next greater---
8130 IFLEFT$(A1$,1)=CHR$(255)THENE=1:ELSEE=0
8140 RETURN
8150 RR=LR:                          '--- Continue at rec no. LR---
8160 GOTO8030
8200 IFGR>0THEN8250:                 '--- Check for end of search--
8210 GOTO8120:                       '--- Borrow a few statements--
8250 RR=GR:                          '--- Continue at rec no. GR---
8260 GOTO8030
```

Text continued from page 240:

zero. This is the first record in the file, physically, and is numbered zero by the way the mathematics of the next subroutine work. This first subroutine simply loads the value, increments it, then resaves it, storing the value of the record in the variable FR (for "free record").

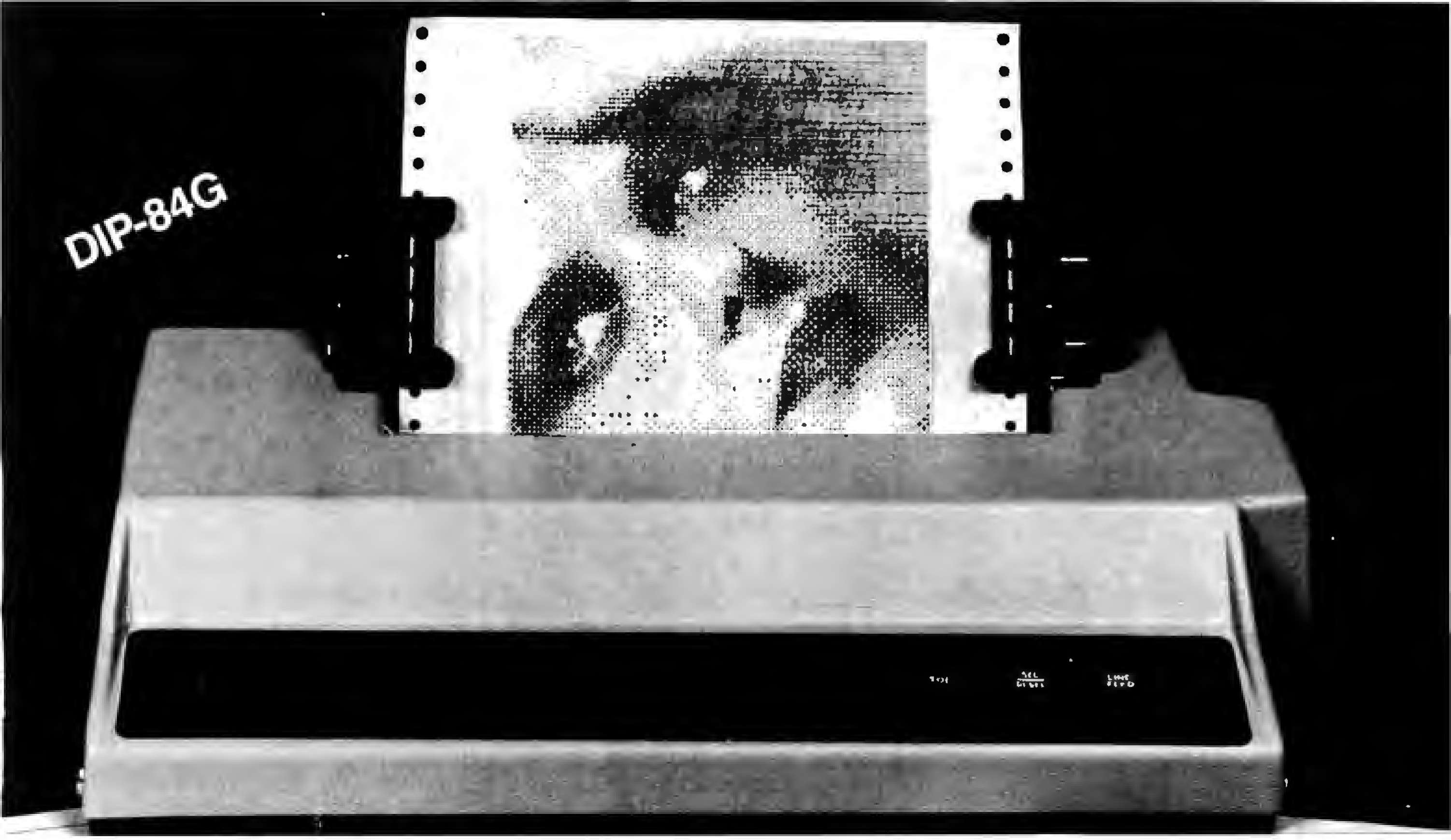
The second subroutine, starting at line 5500, finds a record by number and loads it into memory as the variable A1$. The record number is assumed to be in the variable RR. Since this subroutine set allows for more than one record per file block, a few formulas are required. Lines 5500 through 5520 calculate the number of the block and the relative number (ie: number of the record on the block) of the record. Line 5540 extracts the correct part of the buffer (B$) for the record. Lines 5560 and 5570 "decode" the two greater than and less than pointers so that the other subroutines don't have to deal with that job.

These first two subroutines are there to simply help the other ones. They can be used in any random-access file (except for the unpacking of GR and LR). The rest of the subroutines handle the actual logic of the system.

Line 6000 starts the subroutine that puts a new record into the file. If it is the very first record, it is simply saved as record number one and the two pointers are both set to zero. This happens in lines 6015 through 6090. The subroutine that gets the number of the next available record (line 5000) is used in this subroutine.

If it is not the first record, then a more complicated solution is required; this begins at line 6100. First, the file must be searched for the alphabetical position of the new record. Start with record number one (see line 6100). Before the routine goes any further, it tests the record number to see if there is any more room in the file. If there isn't, then there is no reason to go any further, because the record cannot be added to the file. Note the use of the variable E. This is used as a form of error code. If, when the subroutine returns, E is 0, then everything went as planned. If E is returned as 2 it means that the file is full and the record is not saved. If E is 1, the key is already in the file and the new record is not saved. This will come up later in this subroutine.

The search is somewhat like the binary search. The record is looked up in line 6110, which uses the subroutine at line 5500. Lines 6120 and 6130 test to see which is greater. These branch to other parts of this subroutine. If these two tests "fall through," the record has a key equal to the one to be inserted. Lines 6140 through 6152 take care of this situation. First, E is set to 1 to indicate the error. Next, since the record number



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will not be used, the value of the variable used to count the number of records used must be restored. It was incremented by the GOSUB 5000, so lines 6142 through 6150 decrement it, then 6152 returns to the main program.

If the key to be inserted is less than the key in the record just loaded, line 6120 branches to line 6200. If there are no records indicated by the variable LR (ie:, LR=0), then the spot to link up this new record is found and line 6200 branches to line 6240. If LR does contain a record number, then RR, which is the record number to test, is set to this pointer (LR), and the routine returns to line 6110 to continue the search.

Line 6240 begins the section of program that inserts the record when it is less than the last one found in the search. The *less than* pointer is updated in lines 6240 through 6260 so that it will point to the new record. It is resaved in line 6270, then the routine branches to line 6400 to pack and save the new record.

Between line 6290 and that routine in line 6400 is the routine that handles the situation where the record to be inserted is greater than the record being tested in the search. Line 6130 tests this and branches to line 6300 if the condition is true. This is almost the same as the routine just described that starts at line 6200. The difference is that GR is the pointer used instead of LR.

Line 6400 packs and saves the new record. By the time the routine gets to this line, the record that points to it has been updated. This part of the program just sets up the record and saves it on disk. E is set to 0 just before the RETURN statement to indicate that all went well.

The other two subroutines are variations of the search described for the subroutine that puts a new record into the file. The subroutine starting at line 7000, which gets a record from the file given the key, is the search with the values of the error code (the variable E) set to 0 if the record is found and to 1 if it is not in the file.

The last subroutine allows the reports to be in alphabetical order. It will take a key and find the next one

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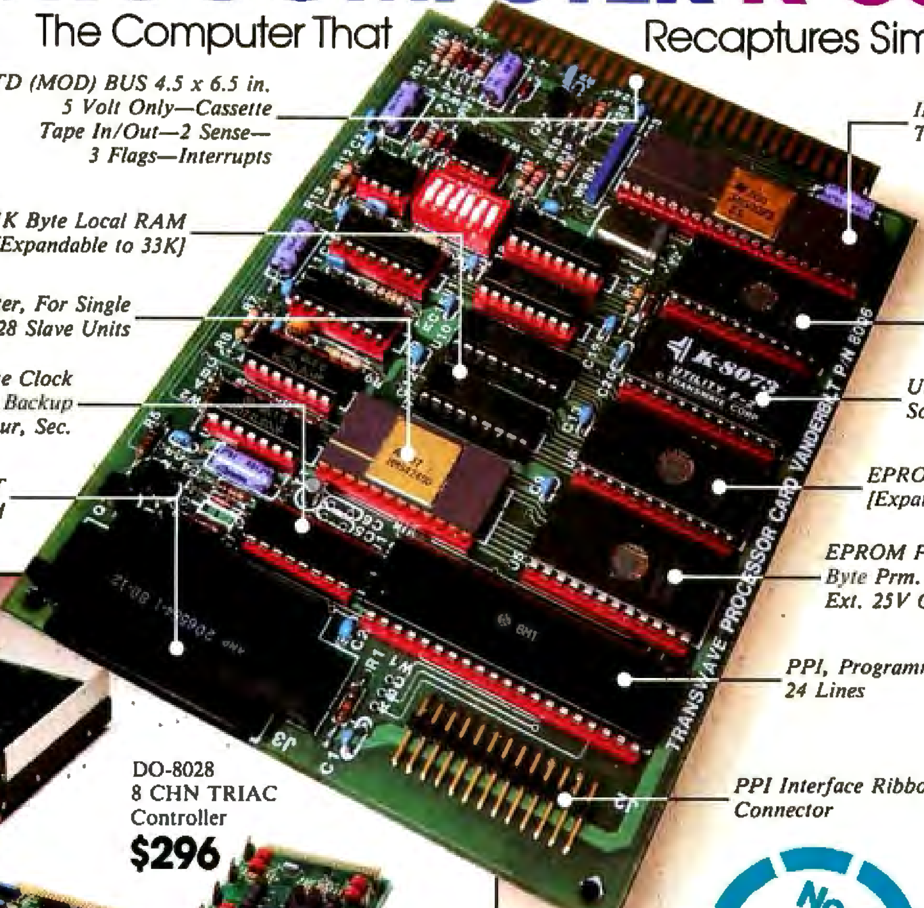

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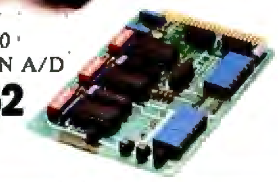

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in the file that is greater. How it works is fairly simple. It first increments the value of the last byte in the key, which makes it the next possible key higher than the one given. It then searches the file in the same manner as the other two subroutines.

If the key is found, there is no problem. The key found is the next higher key in the file. The interesting part is the condition where the key is not found. The key found may not be the next greater key (the "key found" meaning the last one tested in the search). A2$ is used to locate the next greater key. It is initially set to the highest possible value for a string (ASCII code 255). When, in the process of searching, the key loaded is greater than the key being searched (which causes line 8040 to branch to line 8120), the key loaded may be the correct one. It is greater than the one being searched. If it is also less than A2$, then line 8100 sets A2$ equal to it.

The rest of the searching is the same except for the end of the search, which is handled by lines 8120 through 8140. A1$ is the string that is to contain the next greater record, so it is set to A2$. Line 8130 checks to see if a greater key was found. If there are no greater keys in the file, then the first byte of A1$ will be CHR$(255). If it is not, then the next greater key was found. Line 8130 sets E equal to 1 if there are no greater records in file and to 0 if the next greater record is found and returned in A1$.

Deleting Keys

This is the simplest key-file system I know. Like the bubble sort, it is slower than other methods, but is so much simpler to program that it is hard to pass it up in favor of other methods. One drawback, however, is not easy to ignore: there is no way to delete a key. This is due to the pointers. Unless the key was at the end of one of the branches (ie:, both pointers were zero), deleting it would involve changing the pointers of many records. This would be a complicated routine.

A simple solution is to insert a code in the record of a deleted key, leaving the pointers and key intact so that the key will not interfere with future searches. When the file is getting full and there are a lot of deleted records in it, a program can be set up to read this file as a simple random-access file and insert the records that do not have the delete code into a new file using the subroutines. This will form a new file with no deleted records in it.

Accessing the Key File

The program used to access these files will show how to use the subroutines. It begins at line 200 with a selector. The selector lists three selections and requests the operator's choice by number. A "hidden" selection is used to allow initialization of the file. This must be used before the first record is entered and can be used at any time to wipe out all of the records in the file and start out fresh.

The rest of the program is divided by line number into functions corresponding to the selections. The first routine, starting at line 400, is the "hidden" selection (number 27). Lines 430 through 500 request and interpret a password so that some protection in addition to the hidden selection is provided to prevent someone from wiping out your data. Lines 510 through 590 save blocks full of spaces in each block that can be used according to the parameter array. The program then saves a 0 in the first two bytes of record number 0 so that the subroutine at line 5000 can use it as the record counter.

The function starting at line 600 allows the addition of a new record into the file. In this example, the key is the item number and that is requested first. Next, the function uses the subroutine starting at line 7000, which gets the record given the key. If this subroutine finds the key and returns E equal to 0, then the key is already in the file. This causes the error message to be displayed. If it is not found (E=1), then the function proceeds to request the information you want the record to contain. When this has been entered, lines 730 through 790 pack it all into the string A$ and call the subroutine starting at

AH-HA!

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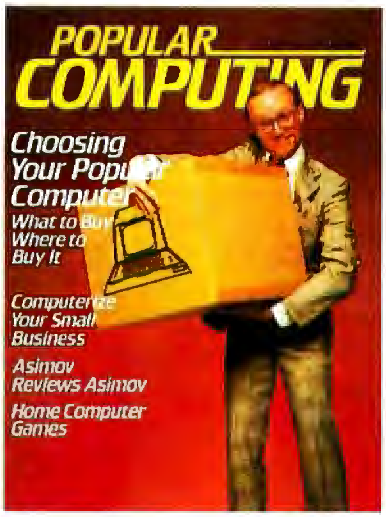

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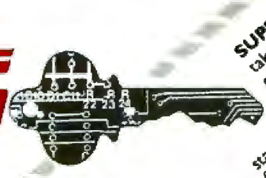

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DATA FILE LAYOUT

FILE *NEWFILE — Inventory file to test subroutines*
FILE TYPE *Key* ACCESS BY *Item Number*

VARIABLE	START	LENGTH	PACK	DESCRIPTION
I$	1	5	Integer	Item no. (key)
GR	6	2	Integer	Greater pointer
LR	8	2	Integer	Lesser pointer
D$	10	14	Alphanumeric	Description
Q	24	2	Integer	Quantity
P	26	4	Single precision	Unit Price

Total Rec. Length = 30
Rec./block = 255/30 = 8
First byte of GR = 6

First byte of LR = 8
Key Length = 5
Rec. in file = 199

Table 1: *A data-file layout form. It shows the variables that the values will be stored in when the record is in the memory and where each field is packed in the memory.*

line 6000 to insert this new record into the file. Note that there is no check for the error code E if E is equal to 1, which indicates that this is a duplicate key, because that was already checked by the subroutine called in line 650. There is a need to check for the end-of-file condition where E is equal to 2. This could be added to the function at this point.

The fields in the file are shown in table 1, which is a data-file layout form. This table shows the variables that the values will be stored in when the record is in the memory and where each field is packed in the record. The information on this sheet is used to determine much of the in-

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Glossary

Array: *A list or table for holding data in such a way that each datum may be accessed by one or two index numbers.*

Binary search: *A method of searching an ordered list for a test value by comparing the test value with the value located at the middle of the list. This procedure effectively divides the list into two sections, and the search proceeds in the section having the value being tested for by, again, comparing the test value with the value located at the middle of the section.*

Character: *A number or symbol that represents some amount (usually 8 bits) of information.*

Fields: *A region of data within a record that refers to the same general properties as corresponding regions in other records.*

Hashing: *A method of searching a list by using a portion of the test value as an index.*

Key: *The field of a record that may be compared with a test value.*

Pointer: *A variable or memory location whose value is the address of a memory location.*

Random-access file: *A disk file whose records may be read in any order.*

Records: *Divisions of data in a file such that each of the divisions contains the same type of information at corresponding positions.*

Search: *To examine a file to locate certain information.*

Sequential file: *A disk file whose records may be read only in sequential order.*

Sort: *To put the records of a file in order according to the data they contain.*

Test value: *The information that a file is being searched for.*

formation required in the parameter array.

The next function, which starts at line 900, allows you to change data in records that have already been saved in the file. Lines 900 through 1030 get the item number to edit, load, and unpack the record, and perform some checking concerning the key entered. The checking consists of two parts. The first allows an "escape" from the function. If the key entered is "END," the function branches back to the selector. The second check is if the record is in the file. If it is not, the message at line 980 is displayed. The checking is on the error code E after the GOSUB 7000.

The rest of this function could take many different forms. The one I used here allows the operator to select, by number, 1, 2, or 3 for the field to edit, 0 to end editing and resave the record, or −1 to end the edit of this item and not post any changes. A −1 simply causes a branch back to the beginning of the function. The 0 is handled in lines 1160 through 1280. Lines 1160 through 1220 repack the fields into the string A$. In order to resave the record, this function first reloads it (the "old" version before the changes were made), then replaces the area in the buffer with the new version of the record.

The last function, the printout, uses the "get next higher key" subroutine. This function begins at line 1400. Lines 1430 and 1440 request the starting and ending keys for the listing. After these are checked (to make sure the starting key is not greater than the ending key), line 1460 decrements the first key. The listing will be in alphabetical order by continually calling the subroutine starting at line 8000, which gets the next higher key. By decrementing the first key, the first key that will be printed could be the key entered, if it is in the file. If this decrementing were not done, and the starting key were a key in the file, the function would start with the next greater key rather than the one entered.

The part of this function that controls which key is to be printed is in lines 1490 and 1500: 1490 gets the next greater key and line 1500 checks for the end-of-file condition. Added

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Recommended Reading

In 1973, Donald E Knuth of Stanford University produced what must be the definitive work on computer-programming techniques: The Art of Computer Programming *(Addison-Wesley). It is a set of three volumes covering nearly every useful software trick, and it rates many varied competing techniques to show what works best under given circumstances.*

Because the computer's main purpose is to keep, sort, and search lists of data (just as the wheel's reason for being is to roll), a large portion of Knuth's work is dedicated to the storage, arrangement, and selection of data. I especially recommend:

Volume 1, Fundamental Algorithms
  Chapter 2, Information Structures (page 228)
Volume 3, Sorting and Searching
  Chapter 5.2, Internal Sorting (page 73)
  Chapter 5.3, Optimum Sorting (page 181)
  Chapter 6, Searching
    section 6.2.1 Searching an Ordered Table (page 406)
    section 6.2.2 Binary-Tree Searching (page 422)

to this control is the logic in line 1510, which checks that the new key is not greater than the ending key, and line 1670, which places the last key printed into A$ for the next search.

The remaining statements simply format the output. Added to the function for the inventory application is the extended value, which is the quantity times the unit price. This is accumulated in line 1650 so that the total value of inventory can be printed at the end of the report.

Possible Modifications

The program given in the listing has no provision for deleting a record. As noted above, a key cannot be deleted from this type of file without extensive reshuffling of the pointers. A few simple alterations can add this function.

The file layout must be altered first to add a one-byte field that is to serve as the delete code. For all active, not-deleted records, this field can store the letter A. When a record is deleted, use it to store the letter D. The easiest way to do this is to shorten the description by one byte and put the code where the last byte of the description was.

Change the two packing routines to reflect this adjustment. There is one in the input section starting at line 740 and there is another one in the edit section starting at line 1160. Also change the printout section at line 1610. Additional changes will also be required to check this byte in the edit and report sections so that a deleted record will not be edited or printed.

In the input section, you may want to introduce some way to change the delete status if the user enters the key of a deleted record. This could be part of the edit function, where it would be easier to program, but it would be easier for the user if it was added to the input section.

The subroutines are fairly short, but they can be made even shorter by combining some code. This is a fairly new subroutine set for me, so it has not been subjected to any refinement. It has passed several tests, but it may still have some bugs. One obvious part of the program that can be shortened is to replace lines 6015 through 6090 with a GOTO 6400. Although the variable use is a little different, these routines do exactly the same thing. You may want to find some of these condensable parts or, since the subroutines work the way they are, you may want to use them without any changes.

The programming was done on a Radio Shack Model III system. Since this uses a form of Microsoft BASIC, adaptation of this program to other systems that also use Microsoft BASIC should not be a big problem. Adaptation to other types of BASIC may be a little more difficult. I hope the structure of the program and the remarks make this task easier for anyone attempting that. ■

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Orchestra-80

Elizabeth Cooper and Yvon Kolya
POB 22
Peterborough NH 03458

Soon after the release of the Radio Shack TRS-80 microcomputer by the Tandy Corporation, programs promising to turn the TRS-80 into a music-producing instrument appeared. These programs used an AM radio to pick up and amplify the RFI (radio-frequency interference) given off by the Z80 microprocessor and its support devices. The RFI produced by carefully arranging routines executed by the computer played recognizable notes through the radio.

The disadvantages to this method were:

- the limited range of notes that could be produced
- the odd timbre of the notes
- distracting noises produced by the system were also played through the radio, usually at the same time as the notes

The next stage in this development involved the use of the cassette-data port. Specific notes were generated by mathematical algorithms. These notes were then sent to the cassette port of the computer, where they were either recorded on tape or played through a small audio amplifier.

This procedure produced a wider range of purer-sounding notes, but they sounded as if they were made by a toy electronic organ rather than by a true musical instrument. This was due to the circuitry used in the TRS-80 to process signals sent to the port.

Now, three years after its appearance on the market, it *is* possible to use the TRS-80 to its fullest capabilities in music generation.

The company responsible for this breakthrough is Software Affair Ltd. The product is Orchestra-80 (see photo 1).

Orchestra-80 claims to be a "unique combination of hardware and software that can turn any 16 K-byte TRS-80 (Model I) Level II into a high-quality musical instrument," and it is.

The hardware is a small circuit board soldered to a 40-pin edge-card connector that attaches to the TRS-80 expansion port, either on the computer keyboard unit or the expansion interface (see photos 2a and 2b). The circuit board has an RCA-type phono jack that can be connected to any hi-fi amplifier with an RCA-type patch cord. The circuit board is not an amplifier, but a buffering device between the TRS-80 and a hi-fi amplifier. This

At a Glance

Name
Orchestra-80

Type
music-generation software/hardware combination

Manufacturer
Software Affair Ltd
473 Sapena Ct, Suite 1
Santa Clara CA 95051
(408) 295-9195

Price
$79.95

Dimensions
2 by 1 by 1¾ inches (hardware)

Documentation
40-page manual

Format
cassette tape

Computer
TRS-80 Model I, Level II, 16 K programmable memory
TRS-80 disk-based Model I

Audience
music schools, teachers, students, and anyone interested in computer-generated music

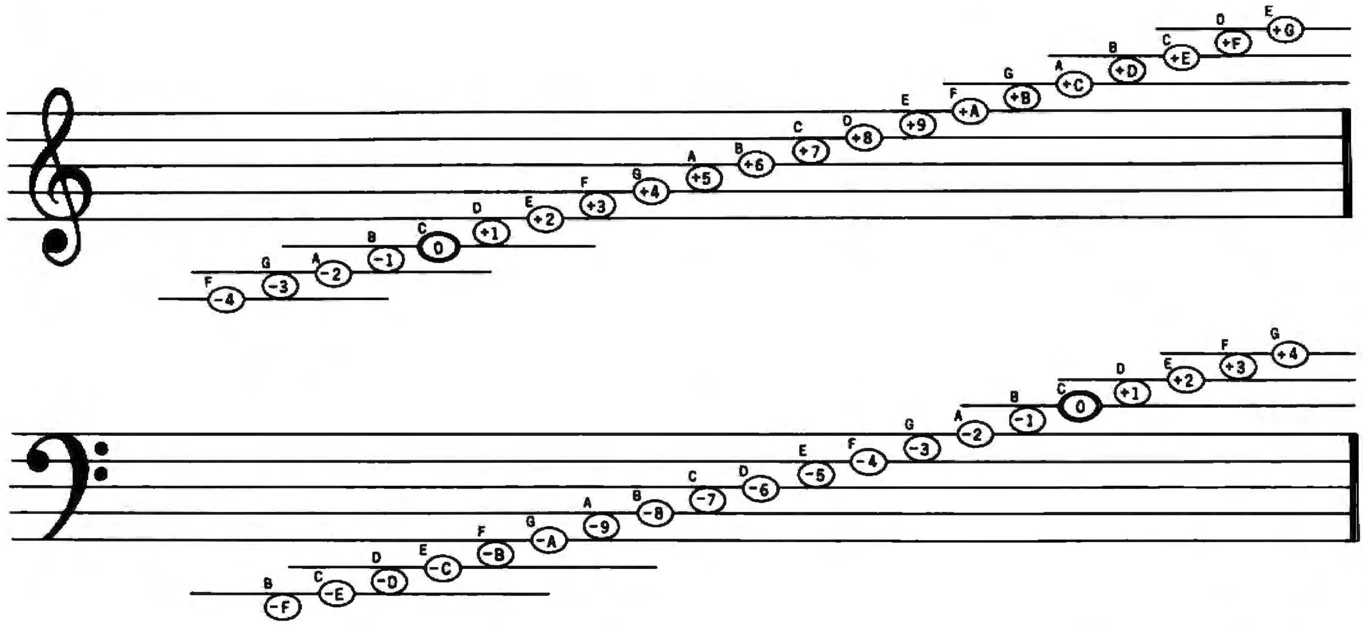

Figure 1: *The correspondence between standard music notation and the code used in Orchestra-80. This figure is on page 26 of the Orchestra-80 instruction manual.*

is one reason for the low cost of the package. Also, this approach lets you use your own high-quality amplifier and avoids the problem of choosing between high-quality sound/high price and low-quality sound/low price.

The software and instruction manual, on the other hand, are more impressive.

After loading the software, you are given an opportunity to have the Orchestra-80 program make a copy of itself. Then you are asked if your computer has a hardware clock speed modification. If it does, and this modification is under software control, you can tell Orchestra-80 what the enable and disable codes are for the changes in clock speed. The program will then automatically disable the clock whenever disk or tape I/O (input/output) is necessary.

The next question deals with whether you want the software to play in three or four voices. Four voices gives you greater flexibility in scoring music; three voices leaves you more memory in which to score music.

Next, you must decide if you want to modify the waveforms of the different registers (ie: voices). The waveform of a register is defined as a sum of sine waves or *partials*. The frequency of each partial is an integer multiple of the fundamental frequency of the register. Up to fifteen partials (also known as harmonics) can be specified, in addition to the fundamental frequency.

Once this has been done, you specify how much (from 0 to 255) each partial should contribute to the overall volume of the register. A value of 0 contributes nothing, while a value of 200 will be twice as loud as a value of 100. Finally, you select the overall volume of each register, as compared with the others.

With these preliminary steps completed, you are ready to begin playing with Orchestra-80.

If the instruction manual appears intimidating or overly complicated to the novice, it is largely because of its thoroughness. It leaves nothing out, from the necessary instructions about installing the hardware and configuring the software, to a section on "How it Works," and the sections on the music-language code.

Not only is the method of transcribing music covered in detail, telling how the music language of Orchestra-80 compares with standard music notation, but there is also a section giving a fine lesson in interpreting the Orchestra-80 music language, as well as understanding musical notation for those unfamiliar with it. Even if you can't read music, you should be able to transcribe most written music, with a little effort.

These instructions are well supplemented with examples and tables summarizing the instructions, including illustrations of written music and how it compares with the notation used by the computer. Two of the figures in the manual show J S Bach's *Capriccio* in standard music notation and in the code used by Orchestra-80. There is also an excellent listing of the symbols used in music, their Orchestra-80 equivalents, and the definitions of these symbols. One of the most helpful diagrams (see figure 1) matches the symbols of the Orchestra-80 scale to their places on the standard musical staff.

The manual is repetitive to a certain extent, but that's not a problem; in fact, it helps clarify some points. The organization is a bit awkward. Some of the simpler, more fundamental instructions come after the more complex ones. A basic section on "Interpreting the music language" starts on page 27, while the section "Transcribing Music," which is a summary of the same information, appears on pages 11 through 13. In between these two sections, you are given lessons on how the synthesizer works, how to use Orchcopy, etc. However, it doesn't take long to become familiar with Orchestra-80's peculiarities and to realize the instructions are more than ade-

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TRS80 MODEL 1 LEVEL II COMPATIBLE	YES	YES	NO
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FLOPPY DISK CONTROLLER	SINGLE/DOUBLE	SINGLE	SINGLE/DOUBLE
SERIAL RS232 PORT	YES	YES	YES
PRINTER PORT	YES	YES	YES
REAL TIME CLOCK	YES	YES	YES
24 X 80 CHARACTERS	YES	NO	NO
VIDEO MONITOR	YES	YES	YES
UPPER AND LOWER CASE	YES	OPTIONAL	YES
REVERSE VIDEO	YES	NO	NO
KEYBOARD	63 KEY	53 KEY	53 KEY
NUMERIC KEY PAD	YES	NO	YES
B/W GRAPHICS, 128 X 48	YES	YES	YES
HI-RESOLUTION B/W GRAPHICS, 480 X 192	YES	NO	NO
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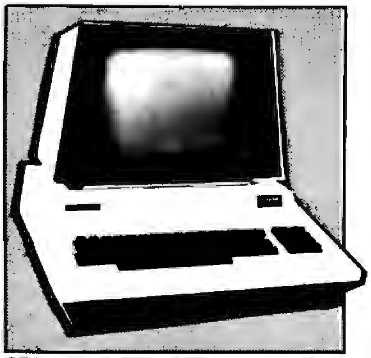
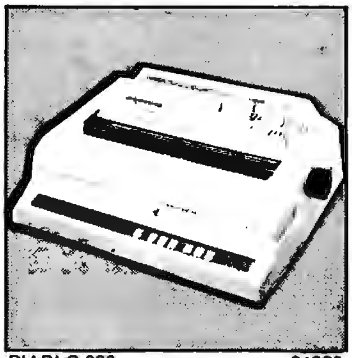
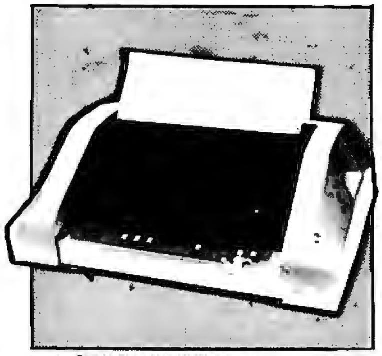


CBM 8032 COMPUTER $1149



DIABLO 630 $1995



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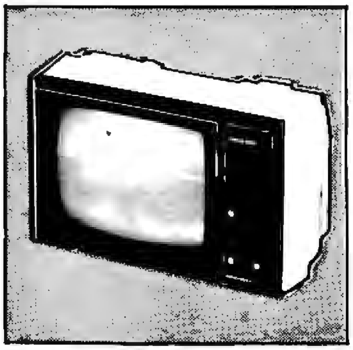

LEEDEX/AMDEK COLOR-1 13" $ 329

Photo 1: *The complete Orchestra-80 system. The system is simple, and is mainly software intensive, as evidenced by the small size of the hardware interface.*

quate.

The editor in Orchestra-80 is easy to use. It uses the arrow keys on the keyboard to position the cursor wherever you want within the piece you are working on. Additionally, you can insert duplicate lines anywhere you want and move lines forward or backward through your file.

When you are finished with a piece, or you want to hear what you have created, type SCORE and any syntax errors will be pointed out. Then type PLAY and listen to what you've typed in.

When you are in the command mode, you can read in previously scored pieces from cassette tape or disk. Pieces can also be "chained" from the storage medium, so several pieces can be played one after the other without intervention from the operator. The disk-based version includes a directory command that lets you see what files are on your disks. Both versions, tape and disk, allow printing of any file in memory, a valuable feature in any program.

The computer code used in composing music is quite straightforward. You can choose any musical key by stating the number of sharps or flats, for example: K1# means the key has one sharp, ie: the key of G.

From there, you can automatically transpose the music to a higher or lower key by inserting a line with the symbol > (greater than) or < (less than) followed by the number of half-steps you wish the music transposed up or down.

On another line, you define the time signature and tempo. (Although a tempo conversion chart is supplied, a limitation of the program is that the tempo must be determined largely by trial and error.)

Next, you define the tone-color registers of up to four voices; in other words, how you want them to sound. A bit of experimentation reveals that if you want the first voice to play with a clear, bright sound and the second voice to have a fuller, more textured sound, you type V1YA V2YD. By defining each of the voices' tones using

When two leaders in the complex information field get together, the results can be surprisingly simple.

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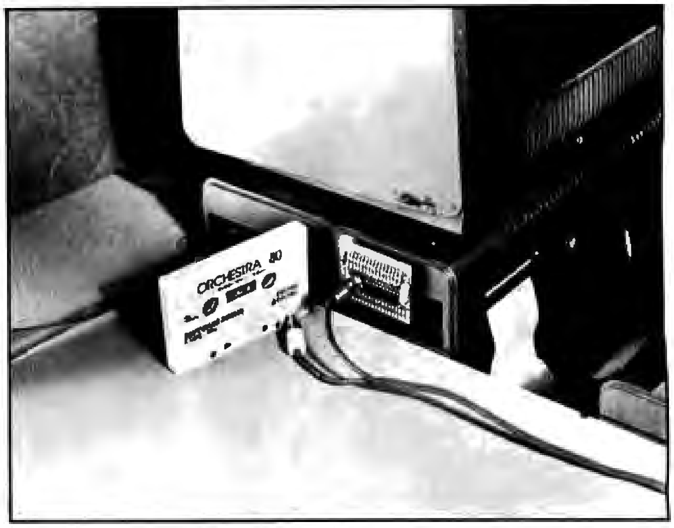

Photo 2: *Orchestra-80 can be connected to either of the expansion connectors available on TRS-80 computer systems.*

A, B, C, or D, in different combinations, you can achieve a variety of effects. When you're ready for the actual notes and rests, you can transcribe anything from whole notes to sixty-fourth notes, dotted notes to triplets, and you can choose whether or not to modify any note with short or long staccato, or short or long articulation. These modifiers determine how sharply a note ends, and give expression to your music. To further alter the mood of a particular phrase or section of music, you can define a new part (P followed by a two-digit number) and change the tempo, tone color, etc, to achieve the desired effect. Repetition of a phrase or an entire part is easily achieved by entering the correct symbols (parenthesis, or R, followed by the number of the part to be repeated).

There is one major limitation to Orchestra-80. It is in the area of dynamics. You can't change the loudness or softness of a phrase—there is no piano, forte, crescendo, or decrescendo. It is possible to compensate somewhat for this by altering the tone-color registers of the voices here and there, but the effect is like that of a modified harpsichord. In fact, the music composed when that instrument was in vogue (the 17th to mid-18th centuries)—the even-tempered, full sound of the baroque period—is particularly suited to interpretation by Orchestra-80, although the program has much wider potential.

Orchestra-80 is an excellent package for the programmer or musician interested in making music with a TRS-80 computer. It requires neither an accomplished programmer nor a professional musician to operate. Its instructions are clear and well written, and the hardware is simple to attach and use.■

Since this review was written, Software Affair has introduced Orchestra-85, featuring stereo output, percussion, new editing features, and an optional fifth voice for use with speed-up modifications; it is compatible with existing Orchestra-80 files. Orchestra-85 costs $129.95. An upgrade for Orchestra-80 systems is also available.

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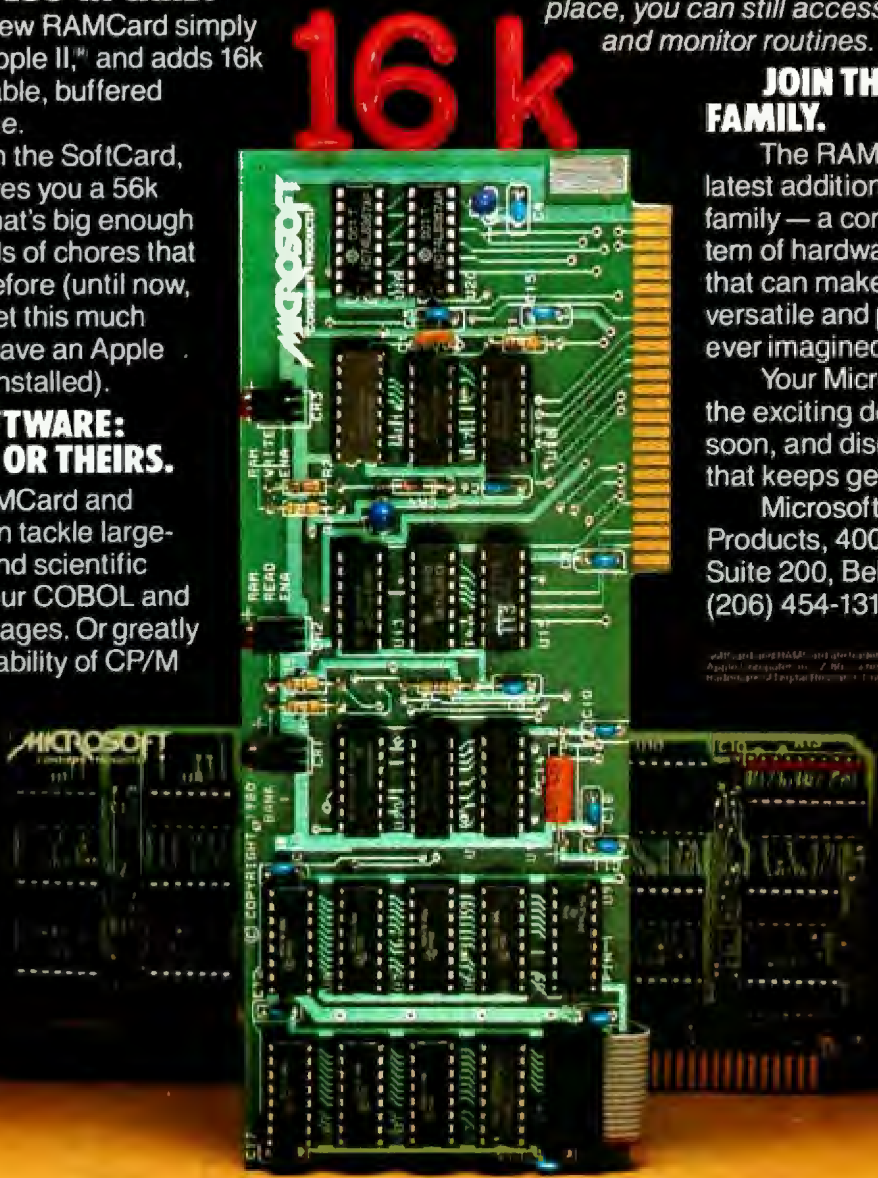

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MICROSOFT

Apple II File-Management Systems

Ken Blochowiak
c/o KRB Associates
POB 11894
Milwaukee WI 53211

[Simonides] inferred that people desiring to train this faculty [of memory] must select places and form mental images of the things they wish to remember and store those images in the places, so that the order of the places will preserve the order of the things, and the images of the things will denote the things themselves.
Cicero, De Oratore

Strictly speaking, the terms *data-base management system, data management system,* and *data-base system* refer to programs that meet the CODASYL (Conference On DAta SYstems Languages) standards for data-base systems. MDBS from Micro Data Base Systems is one such example of a system modeled after the CODASYL standards. The systems we'll be examining are traditionally referred to as file-management systems (see reference 5 for a more complete discussion). Because of various practical limits (such as time and space), we will not cover any programs that run under Digital Research's CP/M operating system.

At the highest level of generality we will be looking at the portability, maintainability, and current utility of the following systems: Infotree, the CCA DMS (Data Management System), the Data Factory, the On-Line Database, and High Technology's DBMS (Data-Base Management System) and Information Master (with Data Master). (See textboxes for addresses and ordering information.)

Portability includes the notion of both the independence of the software from the Apple computer and the independence of your data from the software. Maintainability of the software system includes the ability to back up disks and access the source code. Maintainability of your information includes sort-and-file redefinition facilities. Current utility includes initial definition (system creation), data entry, retrieval, and report printing. Although we will be emphasizing effectiveness, we will also cover several efficiency characteristics, such as whether or not data entry is I/O (input/output) intensive, whether or not disk space is wasted, and whether or not searching or sorting is excessively slow.

Your application and your values determine the importance of these various features. To effectively evaluate the systems, you must know yourself. If you use your microcomputer to produce reports according to country and type of equipment for the multinational corporation you work for, your needs may differ from those you would have if you used your system for order entry and inventory information at your local computer store.

Defining the Features

Portability is divided into machine independence and data-file independence. In the face of the vast uncertainty about what equipment will be obsolete, portability frees you from the need to anticipate. Machine independence gives you the ability to

About the Author

Ken Blochowiak edits a newsletter, called Bits of Data, *for the Cybernetic Mechanism. He is president of KRB Associates, which provides information about Decision Support Systems (DSS) and small computers, and vice chairman of the Milwaukee chapter of the Association for Computing Machinery.*

At a Glance

Name
Infotree

Type
Tree-structured information system

Distributor
Siro-tech
6 Main St
Ogdensburg NY 13669
(315) 393-2640

Price
$70

Format
5-inch floppy disk in UCSD format

Language
UCSD Pascal

Documentation
12 pages

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HP-85 $2575.00

HP-83 $1790.00

HP-83 is the same in capabilities of the HP-85 less the tape storage and printer.

2903A HP+85/83 16K Memory Module $255.00

Firmware Enhancements:			Interfaces:	
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82936A	ROM Draw	$ 42	82937A HP-IB	$339
-15001	Mass Stor.	135	82939A Serial (female)	$399
-15002	Plotter/Prinl	$135	82939 opt 001 (male)	$339
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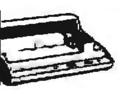
-15005	Adv.Prog.	$274	82941A BCD	$420
-15007	Assembly	$127.5	82949A Printer Int.	$269



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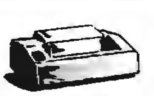

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HP APPLICATION PACS $79.00 each

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85-13037 Regression Analysis

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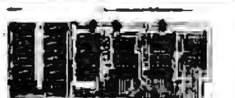
Z-80 Soft Card with CP/M



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16K Ram Card

n your Apple II computer to a larger world. With the Z-80 Soft- d and 16K RAM Card you can now run CP/M compatible software, and your memory for specific application, act as a firmware card much more. If you add any boards to your Apple this year these the ones.

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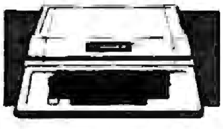
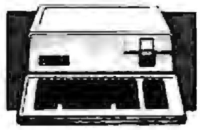
ALS "Smarterm" 80 column card $295.00

intain optimum software compatibility industry wide. By adding the eoterm 80 x 24 videoboard and keyboard enhancer your Apple acts ilar to CRT Terminals on larger systems. Combine this with the rosoft Softcard and you've got some system.

APPLE COMPUTERS



APPLE II "Plus"
16K $1069.00
48K $1129.00



APPLE III
128K $3255.00

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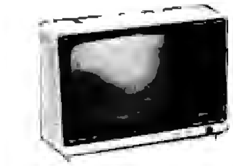
ZENITH MONITOR



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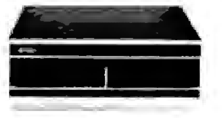

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$1743.00

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- 2200A Mainframe $454
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Your price: $785.00

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move from machine to machine and not waste time learning new software. Data-file independence gives you freedom to use your data file with another file-management system. None of the systems described in this article gives true CODASYL data independence, but some give you more flexibility than others. With a text editor, a copy of the structure of your record, a little analysis, and some programming, you can often achieve considerable flexibility, even if at first glance your record structure seems to be set in concrete.

Maintainability consists of backup, access to source code, sort facilities, and redefinition facilities, and it refers to your ability to continue operating your system. If your data files need some slight changes, if your program has a bug, or if your "locked" (uncopyable) disk doesn't work any more, how do you get up and running again? This area is complicated by the spectre of software piracy and the high mortality rate among new businesses.

Current utility refers to initial definition, data entry, data retrieval, report printing, interface to outside packages, human factors, documentation, and something I call "macro-efficiency." No matter how portable and maintainable a system is, if it's not useful there's no point in having it.

Portability

Infotree is the most *machine-independent* system we will examine here. It is distributed in UCSD Pascal (developed at the University of California at San Diego) *p*-code (pseudo-code) and, with the proper utilities, can be transferred to other UCSD systems. The CCA DMS also has slight

	Infotree	CCA DMS	Data Factory	On-Line Database	DBMS	Data Master	Information Master
Source code available	N	Y	N	N	N	N	N
Copyable disk	Y	Y	N	N	Y	N	N
Characters per field	NA	232	239	26	100	NA	99, alpha 19, numeric
Fields per record	NA	24	88	20	20	NA	20
Characters per record	NA	232	21 K	239	2 K	NA	1980
Select by specified range	N	Y	Y	Y	Y	Y	Y
Select by partial match	N	N	Y	N	N	Y	Y
Select using multiple fields	N	N	Y	N	Y	Y	Y
Allows subsorts	Limited	Y	Limited	Y	Y	NA	Y
Prints mailing labels	Y	Y	Y	Y	Y	NA	Y
User-defined print formats	N	Y	Y	Y	Y	NA	Y
Multiline defined print formats	N	Y	Y	N	Y	NA	Y
Add/delete fields to/from file	Y	N	Y	N	N	Y	N
Merge files	N	N	Y	N	N	Y	N
Calculation options	N	Y	Y	N	Y	Y	Y
In-memory data entry	N	N	Y	Y	N	NA	Limited
Data entry default values	N	N	N	Y	N	NA	Y
Interface to VisiCalc	N	Y	N	N	N	N	N

Table 1: *A quick summary of features for Apple II data-base management systems. DBMS and Information Master are both file-management programs used in conjunction with Data Master, a file-restructuring program. Infotree's tree structure gives record sizes slightly different meanings (each node is identified by a key of up to 18 characters in length; each node can contain up to 18 lines of 26 text characters).*

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Turnkey Systems Corporation
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potential for machine independence; it is available in source code and could be translated into another dialect of BASIC. The other systems (Data Factory, On-Line Database, and High Technology's DBMS and Information Master) come on locked or unlistable disks and have no machine independence.

At a Glance

Name
The Data Factory 3.0

Type
File management and retrieval system

Distributor
Micro Lab
811 Stonegate
Highland Park IL 60035
(312) 433-7877

Price
$150

Format
Locked 5-inch floppy disk

Language
Applesoft BASIC

Documentation
88 pages

At a Glance

Name
CCA Data Management System 5.2

Type
File management and retrieval system

Distributor
Personal Software
1330 Bordeaux Dr
Sunnyvale CA 94086
(408) 745-7841

Price
$100

Format
5-inch floppy disk

Language
Applesoft BASIC

Documentation
130 pages

Infotree does not include any data-file transfer utilities, but there is a text file on the program disk that details how data is stored. Infotree uses a binary tree and consists of a set of records that can be used for text or as nodes in the tree.

The CCA DMS provides utilities for transferring data between VisiCalc and DMS using Software Arts' DIF (Data-Interchange Format). The documentation provides information on the structure of DMS records and examples of the use of this information (including a program that uses DMS files).

The Data Factory provides a Construct/Append option that enables you to read text files created by other systems into Data Factory files. The Data Factory can also add or delete fields in a record and create new files that include the new format and your old data. Information is not provided on the structure of Data Factory files. This system provides flexible methods of moving data into the system, but no documented way of moving data out to other systems.

The On-Line Database does not provide any transfer utilities or file-structure information.

High Technology's DBMS has no utilities that increase flexibility, but both Data Master and Information Master will accept DBMS files. An option for transferring data from Information Master to DBMS is not provided. Data Master can create new DBMS files from old DBMS files.

Data Master is a package of utilities for use with either DBMS or Information Master. It does not document methods of working with files created by other systems. Data Master includes some nice options for adding or deleting fields in a record and for transferring records that meet user-specified criteria to another data file. There is a Data Master equivalent to the command "Select all records where the *ZIP code* field has the value 22153, and the *Amount Owed* field is greater than $10,000; then, transfer only those records to a new data file leaving out the phone number but including a new field called *Comments* whose value is *big spender*. Data Master does supply an extensive set of file restructuring features that are quite useful.

Maintainability

With the coming of the locked disk, a widespread misnomer has developed an appropriate meaning. I refer to "software maintenance." Infotree and the CCA DMA come on copyable disks, which enables you to keep as many backup disks as you wish. The Data Factory comes on two uncopyable disks. "Disk insurance" is available for $17.50 per year. This provides for replacement of blown disks *and* updates to the system. Data Factory disks can also be renewed for a $10 fee if you don't have disk insurance. A backup copy of the On-Line Database is available for $15. When you return High Technology's license, you are sent a backup copy of Data Master or Information Master. DBMS is copyable but it cannot be listed. High Technology says it will replace blown disks for $25.

Only the CCA DMS provides access to source code. Access to source code is reassuring to a purchaser (but see Gemignani's "Legal Protection for Computer Software" for a discussion of the current legal situation concerning software protection).

Infotree provides a file compression option that removes deleted information and improves access time by sorting and relinking the remaining data. Sorting is also done during data entry. The only subsorts are those built into the tree structure (the subbranches of each branch are sorted).

The CCA DMS allows up to ten levels of subsorts. (Whenever two records have the same primary-sort field, they are arranged by the secondary-sort field, and so on.) The use of source and destination disks allows you to sort large files.

The Data Factory allows what amounts to sorting by subfields for day, month, and year. But that's all. And since this information must be in one field, in an invariant format (dd/mm/yy), you lose considerable flexibility of ad hoc query. Of course, you could do without time subsorts (or enter the data twice). Single- or

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dual-drive sorts of a full-disk data file are possible.

The On-Line Database allows subfield sorts. Data is sorted at time of entry, but with reasonably small sets of defined sorts, data entry is not slowed too much.

The High Technology DBMS also allows subfield sorts, but sorting is separated from data entry. An Omit Sort Update option allows Information Master to postpone sorting until the end of your entry or file-modification session. Sorting can also be completely separated from data entry, but some extra work is involved (deleting and redefining sort-definition files). Technically, Data Master performs no sorting, but is simply a utility program for reorganizing files into different formats.

Infotree allows you to add or delete nodes, one by one, to or from your "infotree"—not a particularly powerful method. The On-Line Database doesn't have any facilities of this sort.

There are no explicitly documented methods of adding or deleting fields from an existing CCA DMS data file. But a small file could be transferred to a VisiCalc program that added or deleted columns and transferred back to DMS (a VisiCalc row is a DMS record and a VisiCalc column is a DMS field). This may seem awkward, but it is possible.

The Data Factory has several file redefinition facilities: Construct/Append is the most useful, but Replace and Math can also be useful. Construct/Append allows you to add or delete fields from your record definition, change field length or field position, or append files that have fields of different lengths or in different positions. Replace lets you enter a constant into a specified field of all or selected records. Math lets you do one arithmetic operation involving two fields and store the result in a third field.

Data Master is a comprehensive file-redefinition system. It requires source and destination files created by DBMS or Information Master. It can relocate fields and transfer selected subsets of a file, and create files that have an increase or decrease in the number of fields per record. It can merge files by multiple transfers to the same source file. You can transfer the results of calculations that use up to ten intermediate variables (like a calculator with memory locations) and, apparently, as many arithmetic operations as you have fields. Record selection can be by inequalities, equalities, or pattern matching (leading or trailing string, floating string, or character in a specified position).

Information Master has no file-redefinition options of its own. Its initial file-definition features are required to create Data Master source files. Information Master allows you to load, edit, and save an existing file definition with a new name. A new file definition can be edited until data is entered into the file it defines. This capability simplifies the process of defining new source files for Data Master if the required file is similar to an existing file.

Current Utility

What will these systems do for you right here, right now? We will be examining features that tell you whether or not you can use these systems to define a data file that meets your needs, enter your data easily, get the reports you want, or exchange data with outside packages. We will see whether or not the systems take human factors into consideration, and will look at the documentation and discuss "macroefficiency."

With Infotree, the initial definition of the information structure (which most of the systems refer to as system creation) is intimately related to data entry. As you enter data you create a tree structure. If this structure fits your application naturally and isn't too redundant, it can be very pleasant to use. If it doesn't fit, or results in redundancy, then it isn't pleasant to use. Each node in the tree is identified by a key. Keys may contain up to eighteen letters. Text may be stored at each node. Text lines are twenty-six characters long and multiple lines can be appended. Each node has only one parent but may have multiple children.

The CCA DMS has a close-to-standard record-definition block that includes information on field number, field ID (identification), field name, and field length. Sorts are defined separately. DMS allows you to define fields in which values are calculated automatically. You can say the DMS equivalent of "add field one to field two and put the result in field three." The length of a DMS record must be less than 233 characters, and a record may contain up to twenty-four fields.

The Data Factory has fairly stan-

At a Glance

Name
Data Base Management System (DBMS) 5.2

Type
File management and retrieval system

Distributor
High Technology
POB 14665
8001 Classen Blvd
Oklahoma City OK 73113
(405) 840-9900

Price
$100

Format
5-inch floppy disk

Language
Applesoft BASIC

Documentation
55 pages

At a Glance

Name
Data Master 3.2

Type
File-reorganization utility

Distributor
High Technology
POB 14665
8001 Classen Blvd
Oklahoma City OK 73113
(405) 840-9900

Price
$100

Format
Locked 5-inch floppy disk

Language
Applesoft BASIC

Documentation
36 pages

dard file-definition features, although some are implemented strangely. For example, your field name must not be larger than your field. The tradeoff forced by this peculiarity will be discussed later. A field may have up to 239 characters. The number of fields per record must be less than 89.

Initial definition for the On-Line Database is standard. You specify the number of fields in your record, and for each field you specify its name and length. You can have up to twenty fields per record, twenty-six characters per field, 239 characters per record, nine sort keys per file, and unlimited subsorts per sort (three is recommended as a practical limit).

DBMS gives you simple, direct file-definition features. You can define sorts during or after your initial definitions, and subsorts are allowed. You can have up to twenty fields per record, and 100 characters per field.

Information Master provides extensive system-creation options. You can have up to twenty fields per record, 99 characters per alphanumeric field, nineteen characters per numeric field, five sort keys per file, and five subsorts per sort. Up to 1000 records are allowed per file, but not as many long records will fit on a disk: the number of records is limited to what will fit on one disk.

Data entry for Infotree is disk-I/O intensive (as it is for all systems that don't let you accumulate data in memory). You spend a lot of time waiting for it to write information to disk. Worse, if you need the same information in two separate branches of your tree, you must enter this information twice. Data-entry commands are simple and direct (although they could be better documented).

The CCA DMS does not allow you the option of inspecting and correcting a record after you have finished entering it and before it is saved. If you wish to make corrections, you must use individual search, and update or delete commands. CCA DMS uses the standard prompt: it lists the field names before you enter your data. DMS does not have in-memory data entry.

The Data Factory has good and bad data-entry features. It does have in-memory data entry, but it forces you to choose between cryptic prompts or efficient use of disk. (This is discussed in more detail under macroefficiency.) You *can* verify your entry before moving to the next record.

The On-Line Database has the best data-entry features of any of the systems I have examined. You can define default entries, and do in-memory data entry and avoid waiting for the completion of needless disk I/O. Incorrect entries may be easily corrected by directing the cursor to the spot and reentering the data.

DBMS allows field correction at the end of the entry of a record—it also does error checking. However, it does not allow in-memory data entry or default values. Information Master does not have user-controlled in-memory data entry. Sometimes it accepts more than one record on its own initiative. Sometimes (rarely) it will miss characters because an internal Applesoft operation takes place. It allows you to correct records before saving them to disk, and it beeps after writing to disk. (The previous entry to any field is the default value of the current field.)

The benefit of systems like these comes from the reports they produce. We will examine the way these systems select a record to report, format the report, and calculate any derived results.

Infotree's retrieval commands retrieve either information about the tree structure or information that you have stored at the various nodes. The commands are easy to learn (even though the documentation is a bit sparse), but they are not very powerful. If you do not anticipate the requests you need to make of Infotree and build them into your tree structure, you will not be able to ask them, much less get an answer. If your tree structure goes directly from the "information retrieval systems" node to the specific program nodes without passing through a "for the Apple" node, you will not be able to ask Infotree "what information retrieval systems run on the Apple?"—not even if that information is somewhere further up the tree.

Several record-selection options are scattered through the CCA Data Management System. You can select records that have a particular record number, records that have a particular value in a particular field ("Display all records that have a value of *information system* in the *type of software* field"), and records for

At a Glance

Name
On-Line Database

Type
File management and retrieval system

Distributor
Blue Lakes Computing
3240 University Ave
Madison WI 53705
(608) 233-6502

Price
$100

Format
Locked 5-inch floppy disk

Language
Applesoft BASIC

Documentation
21 pages

At a Glance

Name
Information Master 3.10

Type
File management and retrieval system

Distributor
High Technology
POB 14665
8001 Classen Blvd
Oklahoma City OK 73113
(405) 840-9900

Price
$150

Format
Locked 5-inch floppy disk

Language
Applesoft BASIC

Documentation
145 pages

which the value of a particular field lies within a certain range ("Display all records for which the value of the *cost* field is between $50 and $400"). You cannot, however, do selections that require testing the values of multiple fields ("Display all records where the value of the *host machine* field is *Apple* and the value of the *allows multiple selection criteria* field is *yes*"). The system does select on partial matches. DMS has a somewhat limited set of features that are quite cumbersome to use.

The Data Factory includes several methods of selecting records that are not, however, grouped together. List, Search, Level Search, From/To, Compare, and Inspect/Change are separate main-menu options. The Level Search option allows multiple-criteria searching and searching for partial matches. You can specify record numbers if you wish. A comprehensive set of features is provided, but using them is more difficult than need be.

The On-Line Database does not allow selection by multiple criteria on multiple fields. You can specify a range that the value of a particular field must satisfy in order to select the record ("Select all records for which the *last name* field has a value of *Dijkstra* or greater and *Wirth* or less"). You cannot search for partial matches.

DBMS allows multiple selection criteria on multiple fields. Inequalities are allowed, but not partial matches. Since subsorts are allowed, I consider these features to be reasonably complete. They are certainly very easy to use.

Data Master has sophisticated selection features, but they are used to restructure files. They are not used directly for report purposes. Up to seven selection criteria may be entered. Multiple fields may be tested. You can test for equality, inequality, or pattern match (leading, trailing, floating, or in a particular position).

Information Master provides the same selection features as Data Master. The only difference is that they are used for reports rather than restructuring. They even use the same notation and menu format. Both systems are comprehensive and usable.

Infotree allows you to print mailing labels, text you've stored at a node, or the structure of your tree. You don't have the power to create your own formats, so the program is limited in this area.

The CCA DMS gives good control over the format of your reports. You can create single- or multiple-line formats. Field position is variable in each line. You can save and reuse the formats you've created and use DMS to print mailing labels. Pages can be titled. Formatting features seem reasonably complete, and they're less cumbersome to use than other DMS features.

In-memory data entry speeds up file-management systems by reducing continuous disk-intensive I/O.

The Data Factory allows multiline formats, but gives no spacing option. You can specify the number of fields per line, title your report, print mailing labels, and save formats, but these features are somewhat limited.

The On-Line Database has a mailing-label format, but otherwise does not allow multiline formats. You can specify field position in its single-line format and save these formats. Its features are limited.

Information Master allows you to create up to fifteen report formats per data file. You have up to 15 columns per line. Each column can have a heading, and you can specify that decimal points be aligned. You can also specify totals, subtotals, and algebraic calculations, insert short labels (such as "total," "subtotal," etc), and define multiline formats and print mailing labels. A nice set of features.

DBMS has a mailing-label format and allows multiline printed reports. You can specify which columns your fields are to occupy, insert unchanging characters into your report formats ("literal strings"), and save formats. It's complete and easy to use.

Infotree does not provide any calculation options. Neither does the On-Line Database. The DBMS provides totaling.

The CCA DMS allows you to create calculated fields at the time you define your data file. Available functions are addition, subtraction, multiplication, division, and exponentiation. The total number of characters used in your formulas must be less than 228. Within this limit, you can create as many formulas as you wish and specify which fields should be used to store the results.

The Data Factory provides a calculation option called Math. You can add, subtract, multiply, or divide two fields, and store the result in a third field. You can also receive a report on the total, average, or count (number of records) of a specified field. You can enter selection criteria and use these functions at any time.

Data Master allows you to add, subtract, multiply, or divide one field by another field, or use intermediate variables that you define. The intermediate variables are like memory locations on a calculator. You can use up to ten intermediate variables. Multiple-step calculations are allowed.

Information Master allows the same operations as Data Master, as well as exponentiation and roots. Multiple-step calculations are allowed.

DML (Data-Manipulation Language), as provided by CODASYL data-management systems, lets you read and write information into your data base from outside programs (among other things). None of the systems we're examining gives you a data-manipulation language, but some give you a little help. I get a headache when I think about all the incompatible files I'm collecting and want all the help I can get (see Martin's *Principles of Data-Base Management* for more about data-manipulation languages). Software Arts' DIF (Data-Interchange Format) is used to transfer information to and from VisiCalc and the CCA DMS. If DIF is widely used we might get some relief from incompatability headaches.

Only the CCA DMS provides a di-

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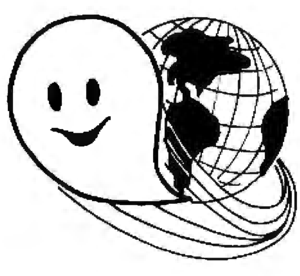

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rect interface to VisiCalc. Perhaps I should qualify that by saying VisiCalc "programs" often require some editing before interchange (unless you like empty fields and literals interspersed in your data). Since VisiCalc provides only primitive filing options and limited information storage in main memory, I expect that many file-management systems for the Apple II computer will eventually supply a direct interface.

Infotree provides a text file that contains information about how to interface your own software to the Infotree data files. Neither the Data Factory nor the On-Line Database provides such information. DBMS has new documentation (which I haven't seen). The old documentation didn't provide any interface information. Both the CCA Data Management System and Information Master provide useful information. DMS and Information Master give you the layout of their files and describe the purpose of each field. The CCA package even includes sample programs.

Commands are simple and direct with Infotree. A help command prints out a list of possible commands with a brief explanation of each command. The command notation is consistent. Infotree is pleasant to run.

There is considerable room for improvement in this area for the CCA DMS. Commands are complex and the formats are not consistent. You must remember the correct places to put commas, exclamation points, apostrophes, and various cryptic codes. (Two good discussions of human factors are Shneiderman, 1980 and Snodgrass, 1980.)

The Data Factory has the largest main menu of any of the seven packages. Many of the main-menu options are slight variations of each other and could easily be grouped together as suboptions of a single main-menu item. This would improve the clarity of the system. The Data Factory asks you whether or not you have a printer each time you boot the system or shift from one data file to another. These are not the characteristics of a considerate system. On the other hand, it does have in-memory data entry (and that shows some consideration for human factors). The Data Factory is a little harder to use than need be.

The On-Line Database is the most understanding in term of human factors. It is menu driven, simple, and direct, and the data-entry features are outstanding. The menus are easy to understand, and because the system searches for the next record as you view the current one, your waiting time is greatly reduced. Very pleasant to use.

DBMS has a few weaknesses (one being an excessively long main menu that distinguishes between "search the data base," "print the data base in user's format," and "print the data with mailing list format"). But, all things considered, it's reasonably well engineered and the menu format is generally uniform throughout the system.

Information Master and Data Master have good consideration for human factors. Menus are not excessively long and commands are grouped logically. Their command structure is less uniform than that of DBMS, but otherwise seems well designed. High Technology made an intelligent decision in using the same command format for both Information Master and Data Master (the two programs were designed for each other). They could have achieved more uniformity within that command format (either letters or numbers for specifying menu options, but not both; a single format for menus, etc), but their consideration for human factors is generally good.

Documentation serves different purposes at different times. The kind of documentation that is best when you're first learning a system is *not* the best when you've had some experience. The writer must include a tutorial, reference material, and consider who the reader is (a novice? A grandmaster? someone in between?).

Infotree's documentation is sparse, but because its user interface is well designed, this is acceptable. A text file on the program disk explains

Text continued on page 292


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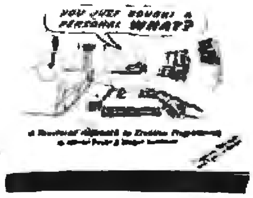

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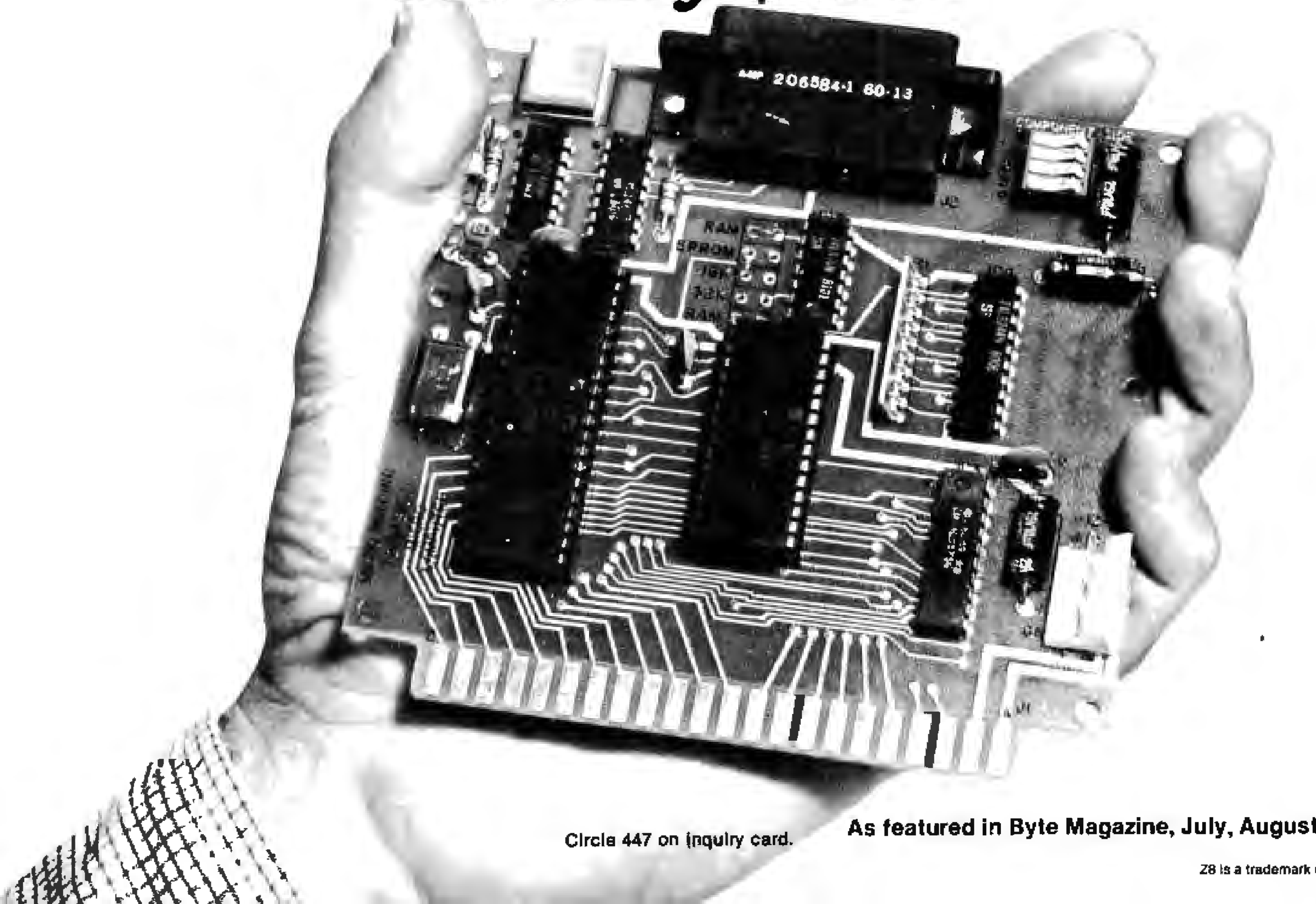

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As featured in Byte Magazine, July, August, 1981.

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Text continued from page 286:

Infotree's file structure. There is a table of contents, but no index. A handful of examples would improve things: Infotree's documentation is tutorial.

The documentation for the CCA Data Management System is clear and quite complete. In addition to all DMS functions (including the transfer of information between DMS and VisiCalc) there is, as previously noted, information on the format of DMS files and how to work with them from your own programs. The documentation includes a table of contents and an index. The documentation is both tutorial and for reference.

The Data Factory has reasonably complete documentation, but unfortunately it is sometimes unclear and most things are only explained once. The structure of the manual follows the structure of the main menu. For the most part, the manual works, but a little more detail (or an example or two) would make things clearer. There is a table of contents, but no index. Acceptable for both initial learning and subsequent reference.

The documentation for the On-Line Database is very clear. It includes a procedure for designing an application using the system and a backup procedure that uses disk rotation (similar to rotating your car's tires). Unfortunately, no descriptions of file structure have been included. There is a table of contents, but no index. It is mainly tutorial, but has some reference uses.

Quite recently, High Technology introduced new documentation for DBMS. The previous documentation was sparse and I haven't seen the new documentation. But since it is reported to be fairly extensive (55 pages), and written by the same person who wrote the documentation for Information Master and Data Master (see the next paragraph), I expect it to be generally good.

The documentation for Data Master is generally good, as is Information Master's documentation. Both manuals have essentially identical virtues. Chapter sections are divided into synopses and tutorial subsections, and examples are numerous and detailed. The manuals go beyond describing the options and what they do; for example, under "Efficient methods for entering data," the Information Master manual describes which options work best for entering large amounts of data that don't need to be accessed prior to completion, and which options work best when data comes in little by little and the data file needs to be accessed in-between. Each manual has a table of contents, a quick reference chart, and an index. They are useful for initial learning and for reference.

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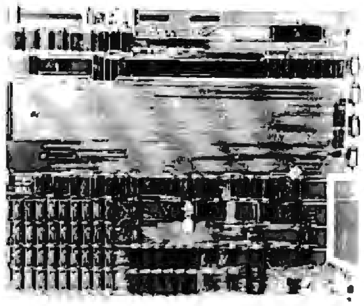

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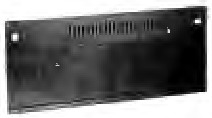

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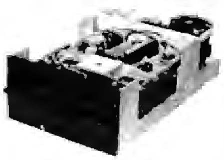

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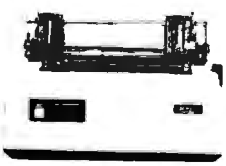

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more extensive discussion of this issue, see Ledgard's *BASIC With Style*.

Only the Data Factory and the On-Line Database have practical in-memory data entry. All the other systems spend a lot of time writing to the disk. Because it regularly requires redundant data entry (if the same information is required by two branches of its tree) Infotree can be even more "inefficient."

All the systems, except the Data Factory, make reasonably efficient use of disk space. Most systems allow you to give your fields a name that is longer than the data field itself. But if you wish to entitle a field "The Number Of Years You've Owned This System," the Data Factory requires you to reserve enough space in your record to hold the entire title. This means that you are regularly forced to choose between cryptic data-entry prompts and fairly large amounts of wasted disk. If you wish to sort your file in more than one order, there is more bad news. The Data Factory requires you to maintain a complete copy of your data file for each sort. Five sorts, five complete copies.

The Data Factory's version of multicriteria selection requires multiple readings of the data file. This is inefficient. By contrast, the On-Line Database searches for the next record that meets your selection criteria while you view the current one. If the time you spend viewing the current record exceeds the search time, your next record seems to arrive the instant you request it.

If you can choose when to sort, sorting speed becomes less important. Both Infotree and the On-Line Database require you to sort during data entry. You have no discretion (Infotree also has a discretionary sort that performs slightly different functions). All the other systems allow you to choose when to sort. If you use a fairly small number of subsorts, On-Line Database and Infotree perform all right. The sorting efficiency of these

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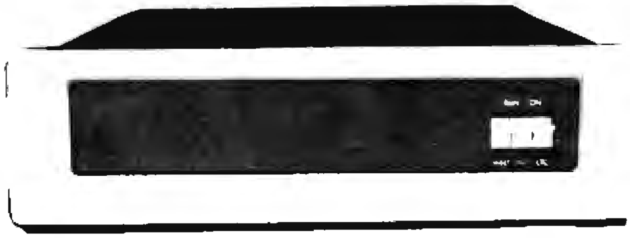

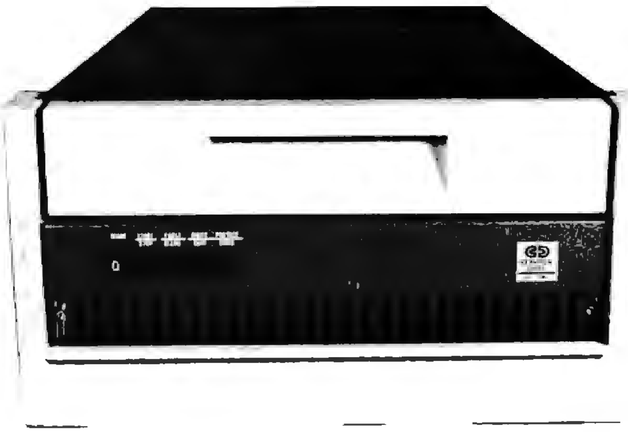

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systems should be sufficient unless your machine is busy more than 50 percent of the time.

The On-Line Database has achieved a significant "macroefficiency" by having the whole program reside in main memory. This eliminates the time the other packages spend swapping modules from disk.

Infotree

Now we will look at our alternatives one by one: what collection of features each system has and how pleasant they are to use. Since Infotree is in UCSD *p*-code, it is fairly machine independent. Lack of file-redefinition features means your data is not so independent. Infotree is copyable, but again, you do not get source code. File maintenance is by individual insertions and deletions. The provided sort utility maintains efficiency of access to the data file. That gives you fair maintainability.

Limitations in Infotree's query method reduce its usefulness. It will print mailing labels, but its formats are set in concrete. Within these limitations, human factors are good. System creation is a part of data entry, and no calculation options are included. Information on interacting with outside packages is provided in a text file on disk, but documentation is sparse. Because tree structures often require redundant branches, Infotree wastes data-entry time and disk space (but only if your application requires redundant branches). There's no in-memory data entry.

For all its limitations, Infotree is an interesting package and a good teaching system. After using it for a while, you will understand tree structures in a very direct way. It has good regard for human factors.

CCA Data-Management System

Since the CCA DMS runs on other systems (in other dialects of BASIC) and since you have access to its source code, you have some machine independence. Because you are given information on the format of its files and because there is a way to use the VisiCalc-to-DMS transfer facilities to restructure your files, you have some freedom.

You can make backup copies of DMS and you can examine its source code. It allows subsorts and full-disk data files. You can define calculated fields when you define your data file. You cannot do multiple-criteria selection on multiple fields. Format control is good (multiple-line formats, mailing labels, saving formats, etc). The CCA DMS is the only system that has an interface to VisiCalc. It provides examples of usage of DMS files by outside programs. Its regard for human factors is poor. Documentation is clear and complete (you'll need it). Other than its lack of in-memory data entry, the efficiency of DMS is acceptable. If the system you get must work with VisiCalc, this is the one.

The Data Factory

Since the Data Factory comes on a locked disk, you have no machine independence. You do get enough file-restructuring options to have some freedom from your initial record structure. Moving data from an arbitrary record structure into the Data Factory is quite simple. You get two uncopyable disks and several options for replacing bad disks. Sort and file redefinition options are sufficient to maintain your data file.

The Data Factory gives you good flexibility of file definition. If your application requires a few large records (up to 88 fields per record and 239 characters per field) the Data Factory will accommodate you. You get in-memory data entry. Selection options are comprehensive (multiple selection on multiple fields is permitted). Calculation options are good. Formatting options permit multiple-line formats. No interface to outside packages of your own software is supplied. Regard for human factors could be better. The menus are too long (that's confusing); several times, tedious sequences of questions are used when a menu would work better; each time you change data files you are asked whether you have one drive or two, etc. It does not provide subsorts, except for the date-field subsort. It *will* let you choose when to sort. The Data Factory gives

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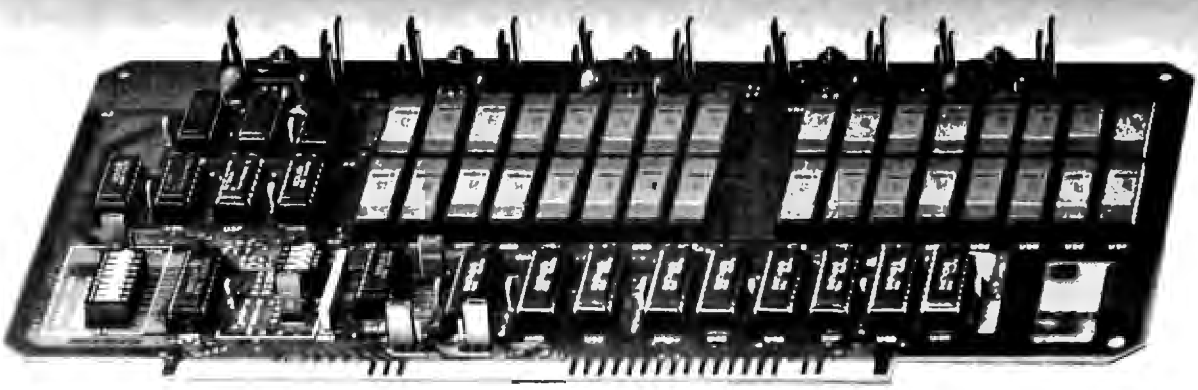

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The On-Line Database

The On-Line Database comes on a locked disk. It does not provide any utilities or information that would help you transfer information from system to system. A backup disk can be purchased for $15. There are no file-redefinition facilities.

Initial definition is easy and subsorts are allowed. The limit of twenty-six characters per field and 239 characters per record might be too confining for some applications. The data-entry options for the On-Line Database are excellent. Default entries, cursor-oriented editing of entries, in-memory data entry, and other options provide outstanding features. No calculation options are provided. Mailing labels and user-defined single-line formats are the only formatting options. Multiple-criteria selection on multiple fields is not allowed, but subsorted keys are available. No interface to outside software is supplied. Documentation has some nice touches (the applications-creation procedure, for example). Sorting is tied to data entry. The entire program resides in memory, eliminating the swapping of modules. While you examine one record, it is searching for the next one. The On-Line Database is well suited to applications requiring fast response. Regard for human factors is *consistently good.* A pleasant system to use.

The High Technology DBMS

DBMS comes on a copyable disk. It has no data-file independence features of its own, but Data Master and Information Master will accept its files. You cannot catalog or list it, but it is copyable. In combination with Data Master, DBMS has extensive file-maintenance features. (Alone it has none.)

The system has standard initial-definition features. It provides subsorts. In-memory data entry is not provided. It can select records for reports using multiple criteria on multiple fields. It allows multiple-line report formats and mailing labels. It will calculate the total and the average of a field, and you can decide when to do your sorts. The only outside software packages DBMS is designed to work with are Data Master and Information Master. Menus have too many options (extra options should be in submenus), but menu format is uniform throughout the system. Fairly good regard for human factors. There is new documentation.

Data Master

Data Master is designed to be used with DBMS or Information Master and comes on an uncopyable disk. There are extensive file-reorganization options. You can merge files (with a series of transfers to a single destination file), you can add or de-

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*Data source: Epson MX-80 Operation Manual

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lete fields to or from records, and you can create subsets of a file that meet certain selection criteria.

Data Master requires a source and destination file defined by DBMS or Information Master. It cannot create its own record definition. Both its documentation (extensive) and its regard for human factors are generally good. Use with outside software is possible but not documented; efficiency is adequate. Data Master is an extremely useful addition to DBMS or Information Master.

Information Master

Information Master comes on an uncopyable disk. As mentioned above, Data Master provides it with considerable redefinition capabilities.

In addition to the standard file-definition options, Information Master can edit existing file definitions (useful if a new application shares some characteristics with an existing one). Your previous entry is the default value of your current entry. Extensive selection and calculation options are available (inequalities, leading strings, trailing strings, floating strings, characters in particular positions). Multiple-criteria selection on multiple fields is permitted. The file information eases the interface of outside software to Information Master. Regard for human factors is generally good (Data Master and Information Master have the same command format). Efficiency is adequate. A very practical system (particularly in combination with Data Master).

Conclusions

- The worst system we could construct using the features these systems provide would have the poor consideration for human factors of the CCA Data Management System, the inflexible tree structure and limited query options of Infotree, the huge menus and inefficient use of disk space of the Data Factory, the limited record size and lack of field redefinition options of the On-Line Database, the nonuniform menu formats of Data Master/Information Master, and the numeric error codes of DBMS. It would come with sparse documentation on a locked disk.
- Even if the traditional distinction between the words "file-management system" and "data-base system" is lost, be aware of the difference between systems that meet the CODASYL data-base standards and those that don't.
- Software Arts' DIF holds out the possibility of relief from data-file-incompatibility headaches.
- The best system we could create using the features these systems provide would have the basic characteristics of the very practical Information Master/Data Master combination; the data entry features, quick response, and general pleasantness of the On-Line Database; the interface to VisiCalc and good documentation of the CCA DMS; the educational value and good regard for human factors of Infotree; the uniformity of command format of DBMS; and the cost per feature of the Data Factory. It would, of course, come in source code on an unlocked disk. ■

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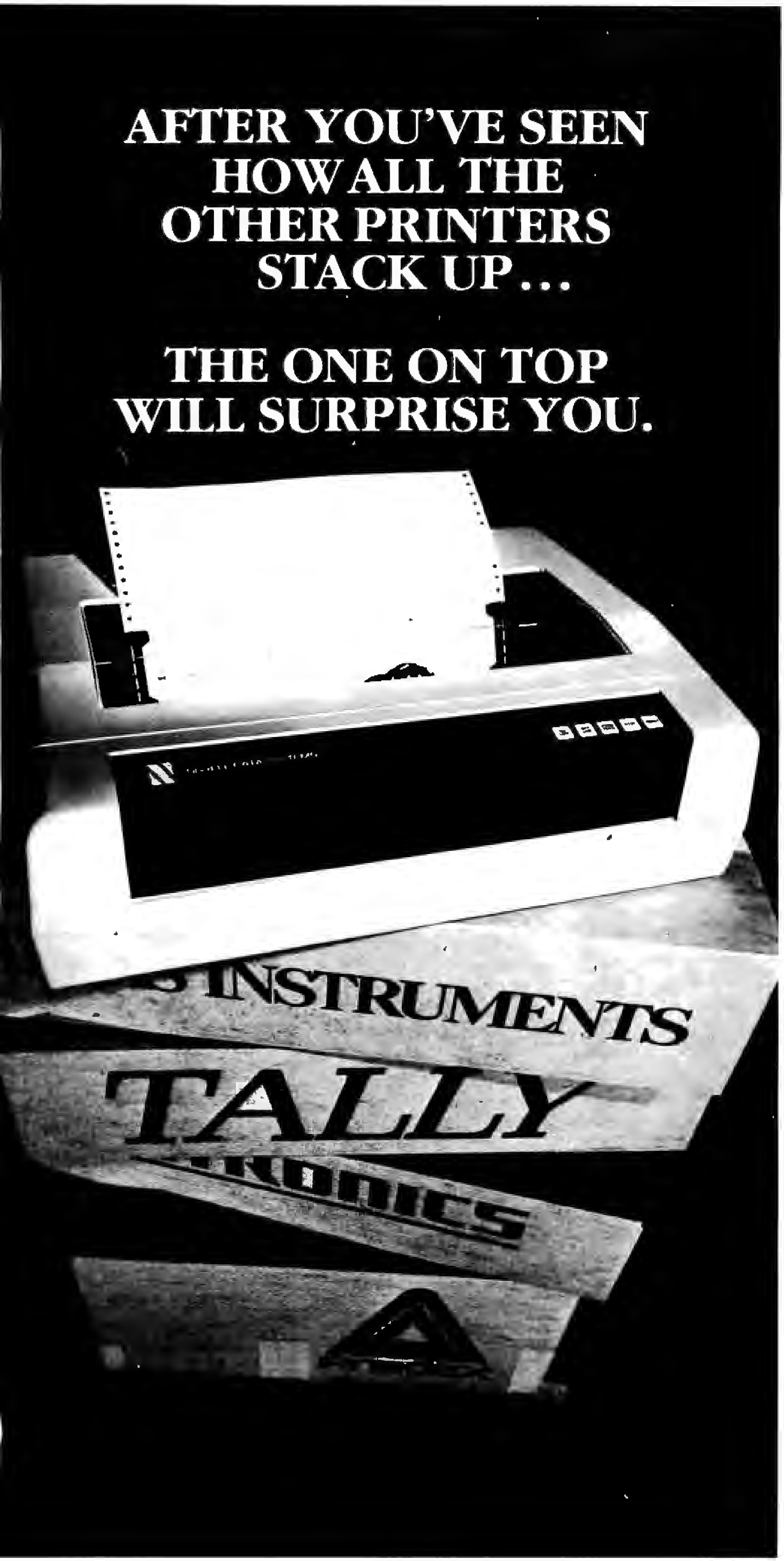

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IEEE S-100 Standard Is On The Way: The IEEE-696 Standard for the S-100 microcomputer bus has been completed by the working group and submitted to the IEEE (Institute of Electrical and Electronics Engineers) Computer Standards Committee for adoption. Formal acceptance is expected by early 1982.

The S-100 bus has been changed radically from its original implementation in 1975 by MITS, who employed the bus in the Altair 8080 microcomputer. New features include 8- or 16-bit-wide data path (to accommodate the new 16-bit microprocessors), direct-memory addressing of up to 16 megabytes (previously 64 K bytes), direct I/O (input/output) addressing for as many as 65,536 ports (previously 256 ports), a new protocol that can handle 16 masters on one bus, timing specifications for 6 MHz clock operation (some manufacturers envision operating at over 10 MHz), and an expanded interrupt system of up to 11 lines (previously 7).

The standard will dispense with pin assignment and timing conflicts that plagued S-100 users because of variations between manufacturers. It also allows for future expansion of the bus to support changes in the state of the art (e.g., 32-bit microprocessors).

The importance of the standard is that there are almost 40 manufacturers of S-100 systems and about 50 others making hundreds of S-100-compatible products. There is no doubt the IEEE 696/S-100 is presently the most powerful microcomputer bus in wide use.

If you would like a copy of the proposed IEEE-696 Standard, write to Sol Libes, IEEE-696 Committee Secretary, POB 1192, Mountainside NJ 07092. Please note that each copy costs $6 in the US and $8 elsewhere (US funds only).

Japanese Find Moving Into US Computer Market Hard: The Japanese are starting to move into the US small-business-computer market in force, but they're finding it more difficult than expected. The Japanese appear prepared for a long-term commitment: most are setting up dealer organizations and developing software packages for their hardware. However, it is becoming evident to the Japanese that their hardware is suited to the American market but their software is not. Because of this, it is likely that their penetration will take two to three years to become significant.

Although NEC (Nippon Electric Corporation) has been selling systems in Japan for more than two years, it has met resistance from American dealers because of a lack of software applicable to the US market. NEC is recruiting software suppliers to overcome this problem.

Mitsubishi introduced its small-business computer in the US in 1979 and boasted that within three years it would have 10% of the market. Now Mitsubishi realizes that the US market is hard to crack. It, too, has met with considerable resistance from dealers and is attempting to have several software packages developed.

Toshiba has taken another tack by opening two computer stores in the Los Angeles area. The stores carry Toshiba's entire line of office products, including its desk-top computer.

Sony appears to be having problems delivering its Series 35 word processor, which was introduced at the beginning of the year. Also, it only just started shipping samples of the new 3½-inch disk drive to OEMs (original-equipment manufacturers). Rumors abound about a Sony personal computer, but none has yet surfaced either in the US or Japan.

Canon has decided to play the role of an OEM, thus passing its CX1 desk-top system's software problems on to distributors. (The CX1 is based on Motorola's 6809 microprocessor.) Canon has disclosed an agreement with a software supplier for seven accounting packages.

Sharp has introduced the YX-3200 small-business system to the US market. It had been sold previously in Japan. For the US version, Sharp has decided to go with Digital Research's CP/M operating system and the software packages currently available to operate under it. Sharp plans to sell the YX-3200 through systems houses, office-machine dealers, and office-supply houses.

Half-Size 5-Inch Floppy Drives Coming: At least three floppy-disk makers will soon introduce 5-inch floppy-disk drives that are only 2⅟₁₆ inches tall (half the height of a standard floppy disk). It will be possible to fit two drives in the space previously occupied by one.

The first "slimline" drive is expected to be introduced by Alps Electric Inc (a Japanese concern). It's actually less than half-size, being only 1¹⅟₁₆ inches high. It will be available in 125 K- and 250 K-byte versions. Remex, Irvine, California, is expected to have its 2⅟₁₆-inch-tall drive out by year's end. The Oyx division of Exxon is making a half-size drive that's already being used in a smart typewriter.

Microprocessor Makers To Add Floating Point: Intel, Motorola, and Zilog will soon be adding floating-point functions (FPFs) to their 16-bit microprocessors. All three will use separate integrated circuits functioning as coprocessors. Intel is already providing samples of its iAPX 86-20, which contains both the 16-bit 8086 microprocessor and the 8087 numeric processor; production is expected to begin early next year.

Motorola plans a coprocessor for its 16-bit 68000 microprocessor but, in the meantime, will supply an FPF firmware package that allows 32-bit multiplication and division. Both Intel and Motorola will conform to the proposed IEEE (Institute of Electrical and Electronics Engineers) FPF Standard. Zilog is rumored working on an FPF device for the Z8000. It should be announced by year's end.

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Japanese Robotics Industry On The Upswing: The Japanese government is subsidizing its nation's robot makers in the same way that the computer industry was backed ten years ago. In April 1980, the Japan Robot Leasing Company was launched. After one year of operation, it is already renting $5.5 million worth of robots and expects to raise this to $12.5 million by the end of next year.

Japanese robot production last year totaled $375 million and is projected to rise to $1 billion by 1985. Last year, only 3% of robotic production was exported. One problem with these figures, however, is that they include human-operator manipulative and pick-and-place machines.

About 40% of the robots are used in the automobile industry, about 20% in electrical machinery manufacturing, and about 10% in plastics molding. There are an estimated 130 robot manufacturers in Japan.

Local Networks ... What's Up? Xerox is staking a big pile of money on the "office of the future" concept using its Ethernet local networking system. The system is intended for lawyers, engineers, analysts, and other professionals wishing to zip documents, data files, graphics, and so forth between offices. Xerox has introduced several pieces of Ethernet equipment of which the latest is the Star workstation. The Star can be used as a stand-alone system or as a communications device between other Stars, file servers, and even non-Xerox equipment via an Ethernet system.

The Star is very impressive. Xerox has invested a great deal of energy in developing a workstation with a highly intelligent user interface. In fact, a user can know next to nothing about computers and still use it proficiently because a four-hour machine-guided set of lessons is provided.

Star's most striking feature is its high-resolution video display that shows you two pages, side by side, exactly as they will appear in hard copy. You can vary character fonts, size detailed graphics, change gray tones, justify columns, move text on the screen, look into separate areas of different documents, and more. Using a standard keyboard, it has a free-roaming cursor controlled by a "mouse" and uses small graphic symbols to signify functions. No particular language is needed to tell the system what to do.

There is no doubt that the Star is ahead of the times—perhaps too far ahead! Despite support from several other vendors (Intel, Digital Equipment Corporation, and Hewlett-Packard), there is still no standard for exchanging information via Ethernet. At this time, the IEEE Local Networking Standard Committee appears hopelessly deadlocked. So there is no guarantee that a file created on an HP (Hewlett-Packard) computer, for example, will be compatible with Star's file-handling capabilities.

Even bigger problems are looming: each week there seems to be another new local-network system announced. Also, some of the personal-computer makers have indicated that they will introduce their own network systems, which, undoubtedly, will be non-Ethernet-compatible. Thus, we appear headed for chaos, where there will be neither hardware nor software compatibility among vendors.

On top of all of this, local networks are expensive: the Star workstation costs $17,000. The Ethernet coaxial cable costs an estimated $2 per foot, plus installation, and an Ethernet file server is more expensive than the Star. Hence, a Xerox Ethernet system appears to be prohibitively expensive for a small business. It is interesting to note that Xerox's new 820 system, with an under-$3000 price tag, does not include any Ethernet interfacing (of course, it could be introduced as an option).

Everyone is watching to see how well Xerox will do with Ethernet. You can be sure that several manufacturers have networking systems in advanced stages and, if they feel it is worthwhile, will quickly jump into the marketplace. This includes IBM, DEC, several personal-computer makers, and the Japanese.

Data-Processing Lawsuits and Awards Increasing: An estimated 600 computer-related lawsuits are before the courts. This is expected to surge up to 5000 by 1985, placing them second only to personal-injury cases.

A typical computer lawsuit costs a company $500,000 and takes seven years to complete. Most cases are the result of an adverse relationship between users and vendors. Users appear to be ignorant of what they are buying and expect the vendor to furnish a system to meet all their requirements, but vendors only offer standard systems. So there is a wide gulf between user expectations and vendor capabilities.

Other causes are poor machine reliability and poor system performance. Many suits involve undercapitalized small systems, software, and consulting firms that would rather sell the wrong machine or software package than to lose a sale. But vendors counter that purchasers are infatuated with the best and fastest hardware rather than concerning themselves with the problems to be solved. Also, many vendor contracts contain phrases that may waive warranties.

In a recent court case, NCR (National Cash Register) was ordered to pay the Glovatorium (a wholesale suede and leather cleaner) $2.3 million. The jury found NCR guilty of willfully selling the Glovatorium a minicomputer package it knew would not work. NCR claimed that it was protected from some of the award by a nonconsequential damages clause in the user contract. The judge overruled the clause, which held that NCR was not liable for any loss of business, profits, or consequential damages suffered by the user.

Newspaper Guild Wants Video-Display Terminals Probed: The president of the Newspaper Guild, Charles A Perlik Jr, has urged a congressional subcommittee to back testing of possible long-term effects on operators of video-display terminals. Perlik conceded that tests performed by the National Institute for Occupational Health and Safety have found the radiation to be minimal; however, he claimed that the incidence of cataracts among video-terminal users at newspapers was unusually high. He asserted that the test included only a small number of terminals in use. The Guild has arranged for the Mount Sinai School of Medicine to conduct a "wide-ranging study."

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Computer Crime On The Rise: Two recently reported crimes involved computers. In the first, a student at San Jose State University was arrested and charged with unauthorized access to systems throughout the state and possibly other countries. The student illegally bypassed the school's security system and used the time to play games with other students, some as far away as Sweden and Taiwan. In the process, he accumulated more than $7000 in long-distance telephone bills. He was also accused of erasing programs belonging to other students.

In the other case, a former programmer in Louisiana was arrested after admitting that he stole more than $100,000 in money orders from a system he had programmed. The programmer had been retained by a software house to remove bugs from a software package being prepared for a customer. In the process of "fixing" the program, he altered the software so that he could write checks that were ignored by the system; consequently, the losses were not revealed.

Computer Science Graduates Command High Starting Salaries: According to a survey conducted by the College Placement Council, this year's computer science college graduates commanded an average starting salary of $20,000. Only engineers—particularly petroleum specialists—earned more (averaging $26,000).

UNIX Vs CP/M: There is no doubt that CP/M is the de facto standard for 8-bit microcomputers. It has been implemented on virtually all 8-bit machines, including the TRS-80, Apple, Heath, Xerox, Wang, Hewlett-Packard, and many of the new Japanese desk-top microcomputers. However, as we move into the 16-bit machine and multiuser/multiprocessing era, CP/M's supremacy is being challenged by UNIX-like operating systems. The battle as to which will be dominant on 16-bit systems is just beginning to develop, and I estimate that it will take another year or two (or possibly three) to determine the victor, if indeed there is one. The battle of words is already raging within the Department of the Army's Readiness Command (DARCOM), in magazines, and on several bulletin-board systems.

The arguments: CP/M currently exists in only one unique version (2.2), compared to at least five versions of UNIX, with more to come when "UNIX-like" systems actually hit the market. UNIX is a multiuser system, while CP/M is a single-user system. File size on UNIX is limited to 1000 megabytes, for CP/M it's 8 megabytes, but both support random-access files. Currently, UNIX runs only on PDP-11-based machines, while CP/M runs on 8080-, 8085-, 8088-, 8086-, and Z80-based machines. UNIX employs a tree-directory structure with an infinite number of levels and path names, whereas CP/M has a dual-level directory structure with a limited path. Both systems allow linking files. There is complete device transparency and redirectability with UNIX, but this is limited in CP/M. UNIX's user interface is contained in a "shell" that is easily replaced. CP/M, however, uses a command control processor that is not easily replaced. UNIX has a complicated command language in comparison to CP/M. UNIX's commands have redirectable I/O (input/output). Only terminal I/O is redirectable in CP/M. UNIX has more extensive wild cards in addition to interprocessor information transfer (pipes) and coroutines, both of which are lacking in CP/M. UNIX has type-ahead, while CP/M may not. UNIX allows parallel processes but CP/M does not. CP/M is limited to 20 arguments, yet UNIX allows indirect command files with no limit to arguments. Conditional and construct execution of files are permitted only in UNIX. Also, UNIX allows shell variables and command substitution that CP/M does not provide.

Both have proven reliability, but UNIX provides better security. UNIX is written in the C language, and CP/M is written in PL/M and assembler. CP/M appears to have much more public-domain and commercial software available for it than does UNIX.

IBM Market Share Eroding: In 1956 when 100% of the computer industry was geared toward big mainframes, IBM shipped 55% of all the data-processing equipment and had a handful of competitors. With the introduction of the minicomputer in 1972, the number of competitors increased to over 600. Last year, because of the microcomputer, the number of computer manufacturers rose to 3000. Although IBM has introduced mini- and microcomputers, its share of units shipped has dropped to 25%.

Random News Bits: Digital Equipment Corporation claims to have more than 100,000 LSI-11 microcomputers in operation. . . . Advanced Micro Devices and Mostek are developing integrated circuits that should reduce the cost of an Ethernet interface from the current $1000 to under $100 by 1983. . . . Seagate Technology, Scotts Valley, California, has introduced a 12.76-megabyte version of a 5-inch Winchester-disk drive. . . . For the second year in a row, Fujitsu reported greater computer sales in Japan than IBM ($2.8 billion compared to $1.6 billion). But IBM reported greater net income ($174 million to $88 million). . . . A recent letter in the *New England Journal of Medicine* reported on a new malady termed "Space Invaders wrist." The symptoms were a reported stiffness and pain in the right wrist. The cause was traced to "a large number of rapid, repetitive arm movements" required to play the Space Invaders game. The optimal treatment is rest. . . . Japanese integrated-circuit makers expect to produce 2 million 64 K-bit dynamic memories per month by year's end. . . . The largest disk drive yet is being developed by Ibis Systems, Duarte, California: 5 gigabytes. . . . A four-color miniature printer that uses 2¼-inch-wide paper will be offered by Alps Electric, Rockville Center, New York. It will cost only $300. . . .

Random Rumors: Digital Reserach of Texas' Big Board single-board microcomputer is rumored to be the heart of the Xerox 820. . . . Xerox is reportedly considering the introduction of an under-$1000 personal computer. It has already built a prototype containing a Z80, 16 K bytes of programmable memory (expandable to 256 K bytes), 64 K bytes of read-only memory, an 80-character by 25-line color display with

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graphics capabilities, radio-frequency modulator, and liquid-crystal display. . . . The Apple IV could be released within the next few months. . . . IBM is said to be negotiating to implement BASIC and a VisiCalc-like package on its Displaywriter word-processing system, thereby acknowledging that it is really a general-purpose computer. . . . Expect about ten Japanese suppliers to enter the 5-inch hard-disk market by the end of next year, which should cause a softening of prices. . . . Rumor has it that a subset of Xerox's Smalltalk has been observed "chatting" at Apple Computer. . . .

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

Logo License Applications Available

The Massachusetts Institute of Technology has announced that it is accepting applications from software distributors for the licensing of the Apple Logo Educational Software System. A review of the prototype of the system is available in the June 1981 BYTE (see page 36). Companies interested in further licensing information should contact: Patent, Copyright & Licensing Office, MIT, 77 Massachusetts Ave, Rm E19-722, Cambridge MA 02139.■

LETTER PERFECT T.M. LJK

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ATARI VERSION 2.0 #2001

Compatible with Atari DOS. Uses proportional font, right justified with Atari 825/Centronics 737, 739 printers. Uses EPSON MX* Series + Graftrax/italicized font. Can mix type fonts on same page; mix boldface and enhanced font in same line with justification. Can be used with 16K Atari/400.*

"Compared to the price of many other word processors, this package is a steal. It does everything the advertisement claims and more. On top of this the software is very easy to use." **A.N.A.L.O.G. MAGAZINE**

APPLE VERSION 5.0 #1001

DOS 3.3 compatible — Use 40 or 80 column interchangeably (Smarterm — ALS; Videoterm-Videx; Full View 80 — Bit 3 Inc.; Vision 80 — Vista; Sup-R-Term — M&R Ent.) Reconfigurable at any time for different video, printer, or interface. **USE HAYES MICROMODEM II*** LCA necessary if no 80 column board, need at least 24 K of memory. Files saved as either Text or Binary. Shift key modification allowed. Data Base Merge compatible with **DATA PERFECT*** by LJK.

"For $150, Letter Perfect offers the type of software that can provide quality word processing on inexpensive micro-computer systems at a competitive price." **INFOWORLD**

DATA PERFECT T.M. LJK

APPLE & ATARI DATA BASE MANAGEMENT — $99.95

Complete Data Base System. User orientated for easy and fast operation. 100% Assembly language. Easy to use. You may create your own screen mask for your needs. Searches and Sorts allowed, Configurable to use with any of the 80 column boards of Letter Perfect word processing, or use 40 column Apple video. Lower case supported in 40 column video. Utility enables user to convert standard files to Data Perfect format. Complete report generation capability. Much More!

EDIT 6502 T.M. LJK

This is a coresident — two pass **ASSEMBLER, DIS-ASSEMBLER, TEXT EDITOR,** and **MACHINE LANGUAGE MONITOR.** Editing is both character and line oriented. Disassemblies create editable source files with ability to use predefined labels. Complete control with 41 commands, 5 disassembly modes, 24 monitor commands including step, trace, and read/write disk. Twenty pseudo opcodes, allows linked assemblies, software stacking (single and multiple page) plus complete printer control, i.e. pagenation, titles and tab setting. User can move source, object and symbol table anywhere in memory. Feel as if you never left the environment of **BASIC**. Use any of the 80 column boards as supported by **LETTER PERFECT**, Lower Case optional with **LCG.**

LJK DISK UTILITY — APPLE $29.95

This menu driven program allows the user to manipulate a variety of different file types. Binary, Text, and Source files may be easily converted into each other. The program may be used with **APPLESOFT*, VISCALC***, and other programs. These program files may be readily adapted for multiple use including editing with **LETTER PERFECT** word processings.

MAIL MERGE/UTILITY — APPLE & ATARI — $29.95

This menu driven program combined with **LETTER PERFECT** allows user to generate form letters and print mailing labels. With the Atari, you may **CONVERT ATARI DOS FILES**, or Visicalc files compatible for editing with **LETTER PERFECT.** Utility creates Data Base files for Letter Perfect.

LOWER CASE CHARACTER GENERATOR — $34.95

Lower Case Character Generator for the Rev. 7, Apple II or II+ computers. When installed, this Eprom will generate lower case characters to the video screen. Lower case characters set has two dot true descenders. Installation instruction included. Manual includes listing of software for full support and complete instructions for shift key modification. Compatible with **LETTER PERFECT.**

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Circle 228 on inquiry card.

BUSINESS and UTILITIES

SPELLGUARD™ (CP/M only) — Price: $219.95 Disk

SPELLGUARD is a revolutionary new product which increases the value of your current word processing system (WORD STAR, MAGIC WAND, ELECTRIC PENCIL, TEXTED EDITOR II and others). Written entirely in assembly language, SPELLGUARD™ rapidly assists the user in eliminating spelling and typographical errors by comparing each word of the text against a dictionary (expandable) of over 20,000 of the most common English words. Words appearing in the text but not found in the dictionary are "flagged" for easy identification and correction. Most administrative staff familiar with word processing equipment will be able to use SPELLGUARD™ in only a few minutes.

MAIL LIST 2.2 (Apple, Atari and North Star diskette only) — Price: $34.95

This program is unmatched in its ability to store a maximum number of addresses on one diskette (minimum of 1100 per disk ette, more than 2300 for "double density" systems!). Its many features include alphabetic and zip code sorting, label printing (1, 2, or 3 up), merging of files and a unique keyword seeking routine which retrieves entries by a virtually limitless selection of user defined codes. Mail List 2.2 will even find and delete duplicate entries. A very valuable program!

FORM LETTER SYSTEM rel. 2 (Atari, North Star and Apple Diskettes only) — Price: $34.95

FORM LETTER SYSTEM (FLS) is the ideal program for creating and editing form letters and address lists. It contains an easy-to-use text editor which produces fully justified text. Special codes are used in the address list to obtain personalized salutations. Form letters are produced by automatically inserting each address into a predetermined portion of your letter. FLS is completely compatible with MAIL LIST 2.2, which may be used to manage and sort your address files.

FLS and MAIL LIST 2.2 are available as a combined package for $59.95.

SORTIT (North Star only) — Price: $29.95 Diskette

SORTIT is a general purpose sorting program written in 8080 assembly language. This program will sort sequential data files generated by NORTH STAR BASIC. Primary and optional secondary keys may be numeric or one to nine character strings. SORTIT is easily used with files generated by DYNACOMP's MAIL LIST program and is very versatile in its capabilities for all other BASIC data file sorting.

PERSONAL FINANCE SYSTEM (Atari and North Star only) — Price: $34.95 Diskette

PFS is a single diskette, menu-oriented system composed of ten different programs. Besides recording your expenses and tax deductible items, PFS will sort and summarize expenses by payee, and display information on expenditures by any of 26 user defined codes by month or by payee. PFS will even produce monthly bar graphs of your expenses by category! This powerful package requires only one disk drive, minimal memory (24K Atari, 32K North Star) and will store up to 600 records per disk (and over 1000 records per disk by making a few simple changes to the programs). You can record checks plus cash expenses so that you can finally see where your money goes and eliminate guesswork and tedious hand calculations.

FAMILY BUDGET (Apple only) — Price: $34.95 Diskette

FAMILY BUDGET is a very convenient financial record-keeping program. You will be able to keep track of cash and credit expenditures as well as income on a daily basis. You can record tax deductible items and charitable donations. FAMILY BUDGET also provides a continuous record of all credit transactions. You can make daily cash and charge entries to any of 21 different expense accounts as well as to 5 payroll and tax accounts. Data are easily retrieved giving the user complete control over an otherwise complicated (and unorganized!) subject.

INTELINK (Atari only) — Price: $49.95 Diskette

This software package contains a menu-driven collection of programs for facilitating efficient two-way communications through a full duplex modem (required for use). In one mode of operation you may connect to a data service (e.g., The SOURCE or MicroNet) and quickly load data such as stock quotations onto your diskette for later viewing. This greatly reduces "connect time" and thus the service charge. You may also record the complete contents of a communications session. Additionally, programs written in BASIC, FORTRAN, etc. may be built off-line using the support text editor and later "uploaded" to another computer, making the Atari a very smart terminal. Even Atari BASIC programs may be uploaded. Further, a command file may be built off-line and used later as controlling input for a time-share system. That is, you can set up your sequence of time-share commands and programs, and the Atari will transmit them as needed; batch processing. All this adds up to saving both connect time and your time.

TEXT EDITOR II (CP/M) — Price: $29.95 Diskette/$33.45 Disk

This is the second release version of DYNACOMP's popular TEXT EDITOR I and contains many new features. With TEXT EDITOR II you may build text files in chunks and assemble them for later display. Blocks of text may be appended, inserted or deleted. Files may be saved on disk/diskette in right justified/centered format to be later printed by either TEXT EDITOR II or the CP/M ED facility. Further, ASCII CP/M files (including BASIC and assembly language programs) may be read by the editor and processed. In fact, text files can be built using ED and later formatted using TEXT EDITOR II. All in all, TEXT EDITOR II is an inexpensive, easy to use, but very flexible editing system.

DFILE (Atari and North Star diskettes only) — Price: $19.95

This handy program allows North Star and Atari disk users to maintain a specialized data base of all files and programs in the stack of disks which inevitably accumulates. DFILE is easy to set up and use. It will organize your disks to provide efficient locating of the desired file or program.

FINDIT (North Star only) — Price: $19.95

This is a three-in-one program which maintains information accessible by keywords of three types: Personal (eg: last name), Commercial (eg: plumbers) and Reference (eg: magazine articles, record albums, etc). In addition to keyword searches, there are birthday, anniversary and appointment searches for the personal records and appointment searches for the commercial records. Reference records are accessed by a single keyword or by cross-referencing two or three keywords.

SHOPPING LIST (Atari and North Star only) — Price: $13.95 Cassette/$16.95 Diskette

SHOPPING LIST stores information on items you purchase at the supermarket. Before going shopping, it will remind you of all the things you might need, and then display (or optionally print) your shopping list and the total cost. Adding, deleting, changing and storing data is very easy. Runs with 16K.

TAX OPTIMIZER (North Star only) — Price: $29.95 Diskette

The TAX OPTIMIZER is an easy-to-use, menu oriented software package which provides a convenient means for analyzing various income tax strategies. The program is designed to provide a quick and easy data entry. Income tax is computed by all tax methods (regular, income averaging, maximum and alternate minimum tax). The user may immediately observe the tax effect of critical financial decisions. TAX OPTIMIZER has been thoroughly field tested in CPA offices and comes complete with the current tax tables in its data files.

EDUCATION

HODGE PODGE (Apple only, 48K Applesoft or Integer BASIC) — Price: $19.95 Cassette/$23.95 Diskette

Let HODGE PODGE be your child's baby sitter. Pressing any key on your Apple will result in a different and intriguing "happening" related to the letter or number of the chosen key. The program's graphics, color and sound are a delight for children from ages 1½ to 9. HODGE PODGE is a non-intimidating teaching device which brings a new dimension to the use of computers in education.

TEACHER'S PET I (Available for all computers) — Price: $11.95 Cassette/$15.95 Diskette

This is the first of DYNACOMP's educational packages. Primarily intended for pre-school to grade 3, TEACHER'S PET provides the young student with counting practice, letter-word recognition and three levels of math skill exercises.

MISCELLANEOUS

CRYSTALS (Atari only) — Price: $ 9.95 Cassette/$13.95 Diskette

A unique algorithm randomly produces fascinating graphics displays accompanied with tones which vary as the patterns are built. No two patterns are the same, and the combined effect of the sound and graphics are mesmerizing. CRYSTALS has been used in local stores to demonstrate the sound and color features of the Atari.

NORTH STAR SOFTWARE EXCHANGE (NSSE) LIBRARY

DYNACOMP now distributes the 21 volume NSSE library. These diskettes each contain many programs and offer an outstanding value for the purchase price. They should be part of every North Star user's collection. Call or write DYNACOMP for details regarding the contents of the NSSE collection.

Price: $9.95 each/$7.95 each (4 or more)
The complete collection may be purchased for $149.95

DYNACOMP CASSETTES

DYNACOMP now offers high-quality DYNACOMP brand name C-20 cassettes for computer use. Each cassette is guaranteed to be defect-free.

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AVAILABILITY

DYNACOMP software is supplied with complete documentation containing clear explanations and examples. Unless otherwise specified, all programs will run within 16K program memory space (ATARI requires 24K). Except where noted, programs are available on ATARI, PET, TRS-80 (Level II) and Apple (Applesoft) cassette and diskette as well as North Star single density (double density compatible) diskette. Additionally, most programs can be obtained on standard (IBM format) 8" CP/M floppy disks for systems running under MBASIC.

STATISTICS and ENGINEERING

DIGITAL FILTER (Available for all computers) — Price: $39.95 Cassette/$43.95 Diskette

DIGITAL FILTER is a comprehensive data processing program which permits the user to design his own filter function or choose from a menu of filter forms. The filter forms are subsequently converted into non-recursive convolution coefficients which permit rapid data processing. In the explicit design mode the shape of the frequency transfer function is specified by directly entering points along the desired filter curve. In the menu mode, ideal low pass, high pass and bandpass filters may be approximated to varying degrees according to the number of points used in the calculation. These filters may optionally also be smoothed with a Hanning function. In addition, multi-stage Butterworth filters may be selected. Features of DIGITAL FILTER include plotting of the data before and after filtering, as well as display of the chosen filter function. Also included are convenient data storage, retrieval and editing procedures.

DATA SMOOTHER (Not available for Atari) — Price: $19.95 Cassette/$23.95 Diskette

This special data smoothing program may be used to rapidly derive useful information from noisy business and engineering data which are equally spaced. The software features choice in degree and range of fit, as well as smoothed first and second derivative calculation. Also included is automatic plotting of the input data and smoothed results.

FOURIER ANALYZER (Available for all computers) — Price: $19.95 Cassette/$23.95 Diskette

Use this program to examine the frequency spectra of limited duration signals. The program features automatic scaling and plotting of the input data and results. Practical applications include the analysis of complicated patterns in such fields as electronics, communications and business.

TFA (Transfer Function Analyzer) — Price: $19.95 Cassette/$23.95 Diskette

This is a special software package which may be used to evaluate the transfer functions of systems such as hi-fi amplifiers and filters by examining their response to pulsed inputs. TFA is a major modification of FOURIER ANALYZER and contains an engineering-oriented decibel versus log-frequency plot as well as data editing features. Whereas FOURIER ANALYZER is designed for educational and scientific use, TFA is an engineering tool. Available for all computers.

HARMONIC ANALYZER (Available for all computers) — Price: $24.95 Cassette/$28.95 Diskette

HARMONIC ANALYZER was designed for the spectrum analysis of repetitive waveforms. Features include data file generation, editing and storage/retrieval as well as data and spectrum plotting. One particularly unique facility is that the input data need not be equally spaced or in order. The original data is sorted and a cubic spline interpolation is used to create the data file required by the FFT algorithm.

FOURIER ANALYZER, TFA and HARMONIC ANALYZER may be purchased together for a combined price of $49.95 (three cassettes) and $59.95 (three diskettes).

REGRESSION I (Available for all computers) — Price: $19.95 Cassette/$23.95 Diskette

REGRESSION I is a unique and exceptionally versatile one-dimensional least squares "polynomial" curve fitting program. Features include very high accuracy; an automatic degree determination option, an extensive internal library of fitting functions; data editing; automatic data and curve plotting, a statistical analysis (eg: standard deviation, correlation coefficient, etc.) and much more. In addition, new fits may be tried without reentering the data. REGRESSION I is certainly the cornerstone program in any data analysis software library.

REGRESSION II (PARAFIT) (Available for all computers) — Price: $19.95 Cassette/$23.95 Diskette

PARAFIT is designed to handle those cases in which the parameters are imbedded (possibly nonlinearly) in the fitting function. The user simply inserts the functional form, including the parameters (A(1), A(2), etc.) as one or more BASIC statement lines. Data and results may be manipulated and plotted as with REGRESSION I. Use REGRESSION I for polynomial fitting, and PARAFIT for those complicated functions.

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MLR is a professional software package for analyzing data sets containing two or more linearly independent variables. Besides performing the basic regression calculation, this program also provides easy to use data entry, storage, retrieval and editing functions. In addition, the user may interrogate the solution by supplying values for the independent variables. The number of variables and data size is limited only by the available memory.

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The Atari Tutorial

Part 3: Player-Missile Graphics

Chris Crawford
Atari Inc
1265 Borregas Ave
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Animation is an important capability of any personal computer system. Activity on the screen adds greatly to the excitement and realism of any program. Certainly, animation is crucial to the appeal of most computer games. More important, an animated image can convey information with more impact and clarity than a static image. It can draw attention to an item or event of importance. It can directly show a dynamic process, rather than indirectly talk about it. Animation must accordingly be regarded as an important element of the graphics capabilities of any computer system.

The conventional way to implement animation with personal computers is to move the image data through the screen memory area. This is a two-step process. First, the program must erase the old image by writing background values (ie: the values of the image "under" the moving one) to the memory containing the current image. Then the program must write the image data to the memory corresponding to the new position of the image. By repeating this process over and over, the image appears to move on the screen.

The essence of the problem of playfield animation: the screen image is two-dimensional, while the image in memory is one-dimensional.

There are two problems with this technique. First, if the animation is being done in a graphics mode with large pixels (picture elements), the motion will not be smooth; the image will jerk across the screen. With other computers, the only solution is to use a graphics mode with smaller pixels (higher resolution). The second problem is much worse. The screen is a two-dimensional image, but the screen memory is organized one-dimensionally. An image that is contiguous on the screen will not be contiguous in the screen memory. The discrepancy is illustrated in figure 1.

The significance of this discrepancy is not obvious until you try to write a program to move such an image. Look how the bytes that make up the image are scattered through memory. To erase them, your program must calculate their addresses. This calculation is not always easy to do. The assembly code just to access a single screen byte at screen location (XPOS,YPOS) would be as shown in listing 1 (this code assumes 40 bytes per screen line).

Clearly, this code to access a screen location is too cumbersome. It is not the most elegant or fastest code to solve the problem. A good programmer could take advantage of special circumstances to make the code more compact or elegant. The point of this is that accessing pixels on a screen takes a lot of computing. The routine in listing 1 takes about 100 machine cycles to access a single byte on the screen. To move an image that occupies, say 50 bytes, would require 100 accesses, 10,000 machine cycles, or roughly 10 ms. This may not sound like much, but if you want to achieve smooth motion, you have to move the object every 17 ms. If there are other objects to move or calcula-

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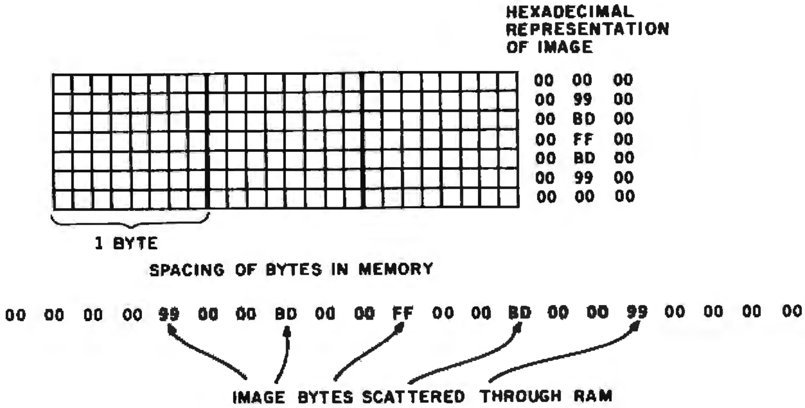

Figure 1: *The problem of moving a bit-mapped graphics image. Although the image is two-dimensional, its representation is scattered through one-dimensional memory. The software necessary to change the appropriate memory locations slows down animation considerably.*

Listing 1: *A 6502 assembly-language program to move a bit-map image within a graphics screen that uses 40 bytes per line of graphics.*

```
LDA   SCRNRM        Address of beginning of screen RAM
STA   POINTR        zero-page pointer
LDA   SCRNRM+1      high-order byte of address
STA   POINTR+1      high-order pointer
LDA   #$00
STA   TEMPA+1       temporary register
LDA   YPOS          vertical position
ASL   A             times 2
ROL   TEMPA+1       shift carry into TEMPA+1
ASL   A             times 4
ROL   TEMPA+1       shift carry again
ASL   A             times 8
ROL   TEMPA+1       shift again
LDX   TEMPA+1       save YPOS*8
STX   TEMPB+1       into TEMPB
STA   TEMB          low byte
ASL   A             times 16
ROL   TEMPA+1
ASL   A             times 32
ROL   TEMPA+1
CLC
ADC   TEMPB         add in YPOS*8 to get YPOS*40
STA   TEMPB
LDA   TEMPA+1       now do high-order byte
ADC   TEMPB+1
STA   TEMPB+1
LDA   TEMPB         TEMPB contains the offset from top of screen to pixel
CLC
ADC   POINTR
STA   POINTR
LDA   TEMPB+1
ADC   POINTR+1
STA   POINTR+1
LDY   XPOS
LDA   (POINTR),Y
```

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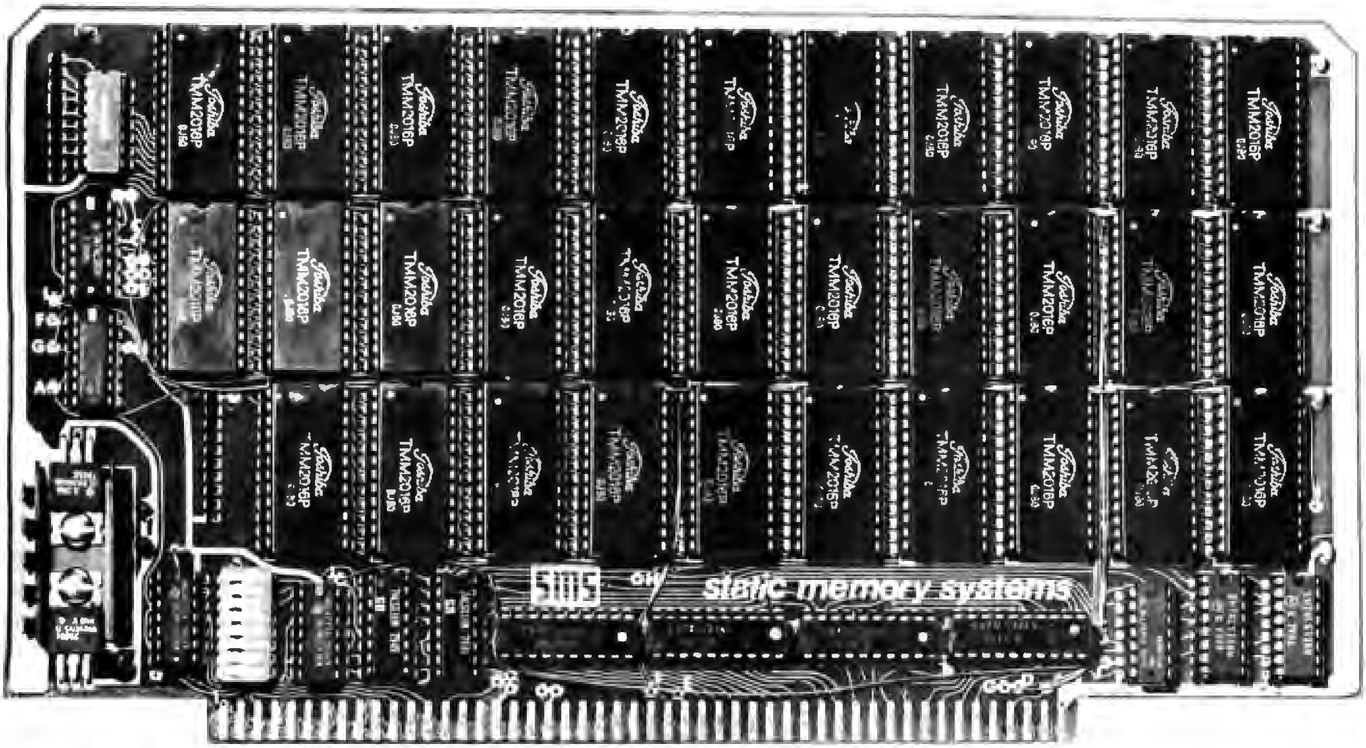

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tions to carry out, the 7 ms difference doesn't allow much processor time to devote to them. This means that this type of animation (called *playfield animation*) is too slow for many purposes. You can still get animation this way, but you are limited to a few objects, small objects, slow motion, or a few calculations between motion. The trade-offs a programmer must make in using such animation are too restrictive.

A New Approach—Players

The Atari 400/800 solution to this problem is player-missile graphics. In order to understand player-missile graphics, you must understand the essence of the problem of playfield animation: the screen image is two-dimensional, while the image in memory is one-dimensional. The solution was to create a graphics object that is one-dimensional on the screen, as well as one-dimensional in memory.

> **What Is Shadowing?**
>
> *Some of the hardware registers talked about in this article are write-only—that is, you can write values to them, but you can't read what their current contents are. Because of this, the designers of the Atari operating system created shadow registers for some of the more important hardware registers. When the Atari 400/800 has finished drawing an entire display screen of information (at a time called the vertical blank), it copies the contents of each shadow register into the corresponding hardware register (this occurs every 1/30 second). In this way, you can read the contents of a shadow register, knowing that it has the same value as its hardware register.*
>
> *If you write to the hardware register itself, the old value (still in the shadow register) will be copied into the hardware register at the next vertical blank, and whatever effect you wanted to make will be almost instantly undone. Similarly, if you try to read the hardware-register location, you will get incorrect results.*
>
> *To conclude, you should always read from and write to shadow registers where they exist. If you fail to do so, your program will fail to work in a way that is not always obvious.*

This object (called a *player*) appears in memory as a table either 128 or 256 bytes long. The table is mapped directly to the screen. It appears as a vertical band stretching from the top of the screen to the bottom. Each byte in the table is mapped into either one or two horizontal scan lines, with the choice made by the programmer. The screen image is a simple bit-map of the data in the table. If a bit is on, the corresponding pixel in the vertical column is lit; if the bit is off, the corresponding pixel is off. Thus, the player image is not strictly one-dimensional; it is actually 8 bits wide.

Drawing a player image on the screen is simple. First, you draw a picture of the desired image on graph paper. This image must be no more than eight pixels wide. Then you translate the image into binary code, substituting 1s for illuminated pixels and 0s for empty pixels. You translate the resulting binary number into decimal or hexadecimal (depending on which is more convenient), and you store 0s into the player memory area to clear the image. Next, you store the image data into the player memory area, with the byte at the top of the player image going first, followed by the other image bytes in top-to-bottom sequence. The further down in memory you place the data, the lower the image will appear on the screen.

Animating this image is easy. Vertical motion is obtained by moving the image data through the player memory. This is, in principle, the same method used in playfield animation, but there is a big difference in practice. The move routine for vertical motion is a one-dimensional move instead of a two-dimensional move. The program does not need to multiply by 40 and it often does not need to use indirection. It could be as simple as:

```
        LDX  #$01
LOOP    LDA  PLAYER,X
        STA  PLAYER-1,X
        INX
        BNE  LOOP
```

This routine takes about 4 ms to move the entire player, about half as

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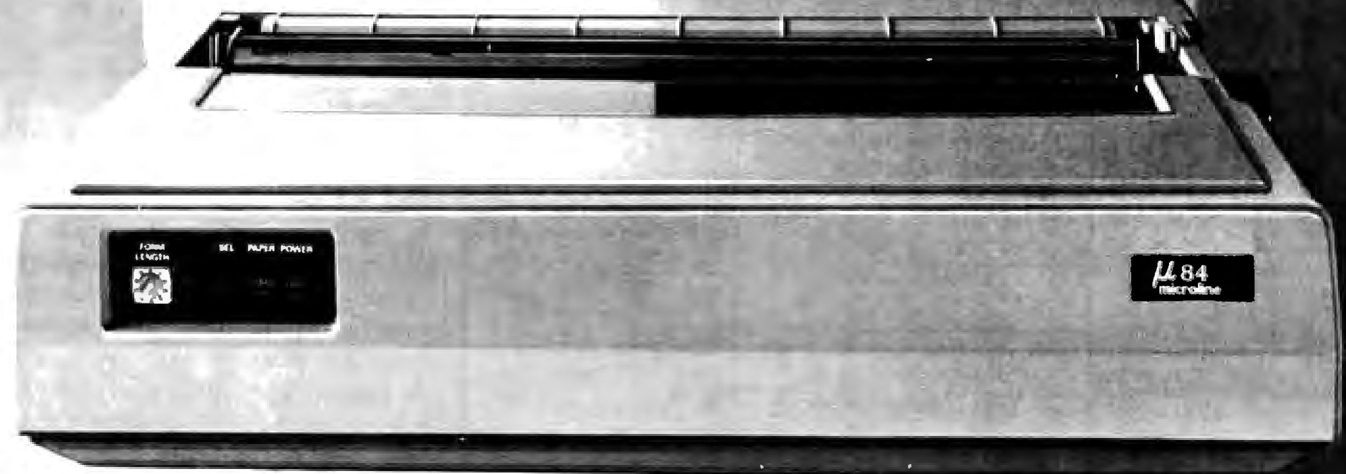

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long as the playfield-animation routine. The player-movement routine is faster than the playfield-animation routine, even though the former moves 256 bytes and the latter moves 50 bytes. If high speed is necessary, the loop above can be trimmed to move only the image bytes themselves, rather than the whole player. Then the loop would easily run in about 100 to 200 μs. The point here is that vertical motion with players is both simpler and faster than motion with playfield objects.

Players and missiles are independent of the playfield—you can mix them with any text or graphics.

Horizontal motion is even easier than vertical motion. There is a register for the player called the *horizontal position register*. The value in this register sets the horizontal position of the player on the screen (ie: the distance from the left edge of the screen). All you do is store a number into this register and the player jumps to that horizontal position. To move the player horizontally, simply change the number stored in the horizontal position register.

Horizontal and vertical motion are independent; you can combine them in any fashion you choose.

The scale for the horizontal position register is one color clock per unit. Thus, adding one to the horizontal position register moves the player one color clock to the right. There are only 228 color clocks in a single scan line. Furthermore, some of these are not displayed because of overscan. The horizontal position register can hold 256 positions, some off the left or right edge of the screen. Depending on the overscan of the television, positions 0 through 44 will be off the left edge of the screen and positions 220 through 255 will be off the right edge. Thus, the visible region of the player is in horizontal positions 44 through 220. Remember, however, that this may vary from television to television; a conservative range is from 60 to 200. This coordinate range is sometimes clumsy to use, but it offers a nice feature: a simple way to remove a player from the screen is to set the player's horizontal position to zero. With a single load and store in assembly language (or a single POKE in BASIC), the player disappears.

The system described so far makes it possible to produce high-speed animation. There are a number of embellishments that greatly add to its overall utility. The first embellishment is that there are four independent players to use. These players all have their own sets of control registers and memory areas; thus, their operation is completely independent. The players are labeled P0 through P3. They can be used side by side to give up to 32 bits of horizontal resolution, or independently to give four movable objects. Each player has its own color register, completely independent of the playfield color register. The player color registers are called COLP(X) and are shadowed at PCOLR(X). This gives you the capability to put much more color onto the screen. However, each player has only one color; multicolored players are not possible without *display-list interrupts* (which will be discussed in the next article in this series).

Each player has a controllable width. You can set it to have normal width, double width, or quadruple width with the SIZEP(X) registers. This is useful for making players take on different sizes. You also have the option of choosing the vertical resolution of the players. You can use single-line resolution, in which each byte in the player table occupies one horizontal scan line, or double-line resolution, in which each byte occupies two horizontal scan lines. With single-line resolution, each player bit-map table is 256 bytes long; with double-line resolution, each table is 128 bytes long. This is the only case where player properties are not independent. The selection of vertical resolution applies to *all* players. Player vertical resolution is controlled by bit D4 of the DMACTL register. In double-line resolution, the first 10 bytes in the player table area are lost to vertical overscan and are off the top edge of the screen, and the last 20 bytes are lost off the bottom edge of the screen. In single-line resolution, 20 and 40 bytes are lost correspondingly.

Missiles

The next embellishment is the provision of *missiles*. These are 2-bit-wide graphics objects associated with the players. There is one missile assigned to each player; it takes its color from the player's color register. Missile-shape data come from the missile bit-map table in memory in front of the player tables. All four missiles are packed into the same table (four missiles times 2 bits per missile gives 8 bits). Missiles can move independently of players; they have their own horizontal position registers. Missiles have their own size register, SIZEM, that can set the horizontal width as the SIZEP(X) registers do for players. However, missiles cannot be set to different sizes. They are all set together. Missiles are useful as bullets or for skinny vertical lines on the screen. If desired, the missiles can be grouped together into a fifth player, in which case they take the color of playfield color register 3. This is done by setting bit D4 of the priority control register (PRIOR). Missiles can still move independently when this option is in effect. Their horizontal positions are set by their horizontal position registers (HPOSM0 through HPOSM3). Their shapes and vertical positions are determined by which bits are turned on in their area of the player-missile area (see figures 2a and 2b). The fifth player enable bit only affects the color of the missiles.

You move a missile vertically the same way you move a player: by moving the missile-image data through their two bit-positions of the missile memory area. This can be difficult to do because missiles are grouped into the same memory table. To access a single missile, you must ignore the bits for the other missiles.

An important feature of player-missile graphics is that players and missiles are completely independent of the playfield (ie: the text or graphics information also displayed by the computer). You can mix them with *any* text or graphics mode. This raises a problem: What happens if a player ends up on top of a playfield image? Which image has priority? You have the option to define the priorities used in displaying players.

Four priority schemes are possible (see the listing for register PRIOR in appendix B). If you wish, all players can have priority over all playfield color registers. Or you can set all playfield color registers (except background) to have priority over all players. Or you can set player 0 and player 1 (P0 and P1) to have priority over all playfield color registers, with P2 and P3 having less priority than the playfield. Or you can set playfield color registers 0 and 1 (PF0 and PF1) to have priority over all players, which then have priority over PF2 and PF3. These priorities are selected with the priority control register (PRIOR) that is shadowed at GPRIOR. This capability allows a player to pass in front of one image and behind another, allowing three-dimensional effects.

Who Did I Just Hit?

The final embellishment is the provision for hardware collision detection. This is primarily of value for games. You can check if any graphics object (player or missile) has collided with anything else. Specifically, you can check for missile-player collisions, missile-playfield collisions, player-player collisions, and player-playfield collisions. There are fifty-four possible collisions, each one with a bit assigned to it that can be checked. If the bit is set, a collision has occurred. These bits are mapped into fifteen registers in CTIA (another custom integrated circuit in the Atari 400/800); only the lower 4 bits are used and some are not meaningful. These are read-only registers; they cannot be cleared by writing zeros to them. The registers can be cleared for further collision detection by writing any value to register HITCLR. All collision registers are cleared by this command.

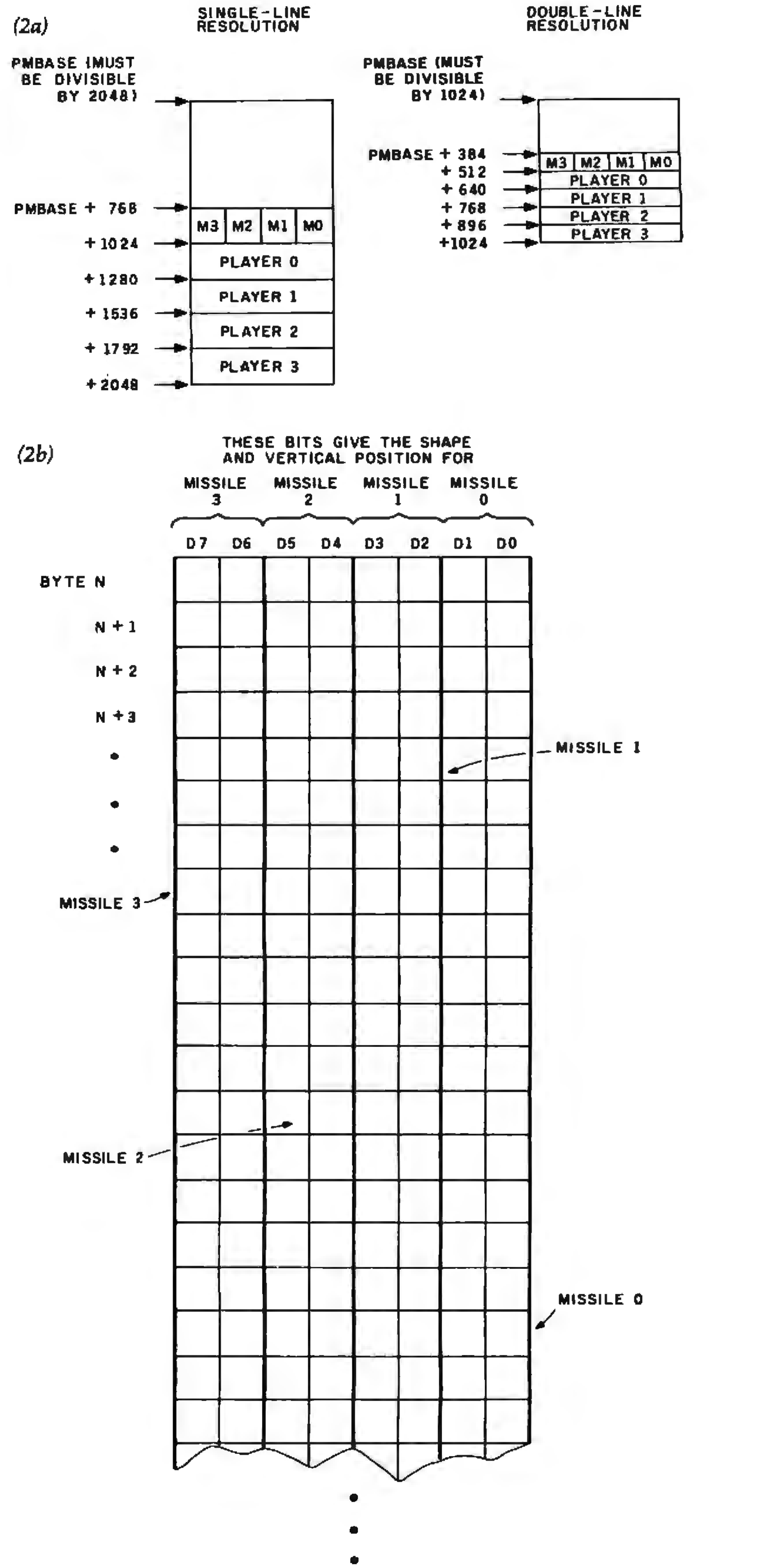

Figure 2: *The player-missile area. Information on the shape and vertical position of the players and missiles is kept in a block of memory. The allocation for single-line and double-line player-missile areas is shown in figure 2a. Figure 2b shows how one area can store the shape and position of four missiles.*

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In hardware terms, collisions occur when a player image coincides with another image. Thus, the collision bit will not be set until the part of the screen showing the collision is drawn. This means that collision detection might not occur until as many as 16 ms have elapsed since the player was moved. The preferred solution is to execute player motion and collision detection during the vertical-blank interrupt routine. In this case, collision detection should be checked first, then collisions cleared, then players moved. Another solution is to wait at least 16 ms after moving a player before checking for a collision involving that player.

Using Player-Missile Graphics

There are a number of steps necessary to use player-missile graphics. First, you must set aside an area of RAM (random-access read/write memory) as a player-missile area and tell the computer where it is. If you use single-line resolution, this area will be 1280 bytes long; if you use double-line resolution, it will be 640 bytes long. A good practice is to use the memory area in front of the display area at the top of the computer's available RAM. The layout of the player-missile area is shown in figure 2.

The pointer to the beginning of the player-missile area is labeled

Listing 2: *An Atari BASIC program that draws a player on the screen and allows the user to move the figure with a joystick.*

```
  1 PMBASE=54279:REM                      player-missile base pointer
  2 RAMTOP=106:REM                        OS top of RAM pointer
  3 SDMCTL=559:REM                        RAM shadow of DMACTL register
  4 GRACTL=53277:REM                      CTIA graphics control register
  5 HPOSP0=53248:REM                      horizontal position of P0
  6 PCOLR0=704:REM                        shadow of player 0 color
 10 GRAPHICS 0:SETCOLOR 2,0,0:REM         set background color to black
 20 X=100:REM                             BASIC's player horizontal position
 30 Y=48:REM                              BASIC's player vertical position
 40 A=PEEK(RAMTOP)-8:REM                  get RAM 2 K below top of RAM
 50 POKE PMBASE,A:REM                     tell ANTIC where PM RAM is
 60 MYPMBASE=256*A:REM                    keep track of PM RAM address
 70 POKE SDMCTL,46:REM                    enable PM DMA with 2-line res
 80 POKE GRACTL,3:REM                     enable PM display
 90 POKE HPOSP0,100:REM                   declare horizontal position
100 FOR I=MYPMBASE+512 TO
    MYPMBASE+640:REM                      this loop clears player
110 POKE I,0
120 NEXT I
130 FOR I=MYPMBASE+512+Y TO
    MYPMBASE+518+Y
140 READ A:REM                            this loop draws the player
150 POKE I,A
160 NEXT I
170 DATA 8,17,35,255,32,16,8
180 POKE PCOLR0,88:REM                    make the player pink
190 A=STICK(0):REM                        read joystick
200 IF A=15 THEN GOTO 190:REM             if inactive, try again
210 IF A=11 THEN X=X-1:POKE HPOSP0,X
220 IF A=7 THEN X=X+1:POKE HPOSP0,X
230 IF A<>13 THEN GOTO 280
240 FOR I=8 TO 0 STEP -1
250 POKE MYPMBASE+512+Y+I,PEEK
    (MYPMBASE+511+Y+I)
260 NEXT I
270 Y=Y+1
280 IF A<>14 THEN GOTO 190
290 FOR I=0 TO 8
300 POKE MYPMBASE+511+Y+I,PEEK
    (MYPMBASE+512+Y+I))
310 NEXT I
320 Y=Y-1
330 GOTO 190
```

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7	DEPRSL	Straightline depreciation
8	DEPRSY	Sum of the digits depreciation
9	DEPRDB	Declining balance depreciation
10	DEPRDDB	Double declining balance depreciation
11	TAXDEP	Cash flow vs. depreciation tables
12	CHECK2	Prints NEBS checks along with daily register
13	CHECKBK1	Checkbook maintenance program
14	MORTGAGE/A	Mortgage amortization table
15	MULTMON	Computes time needed for money to double, triple, etc.
16	SALVAGE	Determines salvage value of an investment
17	RRVARIN	Rate of return on investment with variable inflows
18	RRCONST	Rate of return on investment with constant inflows
19	EFFECT	Effective interest rate of a loan
20	FVAL	Future value of an investment (compound interest)
21	PVAL	Present value of a future amount
22	LOANPAY	Amount of payment on a loan
23	REGWITH	Equal withdrawals from investment to leave 0 over
24	SIMPDISK	Simple discount analysis
25	DATEVAL	Equivalent & nonequivalent dated values for oblig.
26	ANNUDEF	Present value of deferred annuities
27	MARKUP	% Markup analysis for items
28	SINKFUND	Sinking fund amortization program
29	BONDVAL	Value of a bond
30	DEPLETE	Depletion analysis
31	BLACKSH	Black Scholes options analysis
32	STOCVAL1	Expected return on stock via discounts dividends
33	WARVAL	Value of a warrant
34	BONDVAL2	Value of a bond
35	EPSEST	Estimate of future earnings per share for company
36	BETAALPH	Computes alpha and beta variables for stock
37	SHARPE1	Portfolio selection model-i.e. what stocks to hold
38	OPTWRITE	Option writing computations
39	RTVAL	Value of a right
40	EXPVAL	Expected value analysis
41	BAYES	Bayesian decisions
42	VALPRINF	Value of perfect information
43	VALADINF	Value of additional information
44	UTILITY	Derives utility function
45	SIMPLEX	Linear programming solution by simplex method
46	TRANS	Transportation method for linear programming
47	EOQ	Economic order quantity inventory model
48	QUEUE1	Single server queueing (waiting line) model
49	CVP	Cost-volume-profit analysis
50	CONDPROF	Conditional profit tables
51	OPTLOSS	Opportunity loss tables
52	FQUOQ	Fixed quantity economic order quantity model
	NAME	**DESCRIPTION**
53	FQEOWSH	As above but with shortages permitted
54	FQEOQPB	As above but with quantity price breaks
55	QUEUECB	Cost-benefit waiting line analysis
56	NCFANAL	Net cash-flow analysis for simple investment
57	PROFIND	Profitability index of a project
58	CAP1	Cap. Asset Pr. Model analysis of project
59	WACC	Weighted average cost of capital
60	COMPBAL	True rate on loan with compensating bal. required
61	DISCBAL	True rate on discounted loan
62	MERGANAL	Merger analysis computations
63	FINRAT	Financial ratios for a firm
64	NPV	Net present value of project
65	PRINDLAS	Laspeyres price index
66	PRINDPA	Paasche price index
67	SEASIND	Constructs seasonal quantity indices for company
68	TIMETR	Time series analysis linear trend
69	TIMEMOV	Time series analysis moving average trend
70	FUPRINF	Future price estimation with inflation
71	MAILPAC	Mailing list system
72	LETWRT	Letter writing system-links with MAILPAC
73	SORT3	Sorts list of names
74	LABEL1	Shipping label maker
75	LABEL2	Name label maker
76	BUSBUD	DOME business bookkeeping system
77	TIMECLCK	Computes weeks total hours from timeclock info.
78	ACCTPAY	In memory accounts payable system-storage permitted
79	INVOICE	Generate invoice on screen and print on printer
80	INVENT2	In memory inventory control system
81	TELDIR	Computerized telephone directory
82	TIMUSAN	Time use analysis
83	ASSIGN	Use of assignment algorithm for optimal job assign.
84	ACCTREC	In memory accounts receivable system-storage ok
85	TERMSPAY	Compares 3 methods of repayment of loans
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93	INSFILE	Insurance policy file
94	PAYROLL2	In memory payroll system
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PMBASE. Because of internal limitations of the ANTIC device (a custom integrated circuit in the Atari computers), PMBASE must be on a 1 K-byte boundary for single-line resolution, or a 2 K-byte boundary for double-line resolution. If you elect to use less than four players or none of the missiles, the areas of memory set aside for the unused objects may be used for other purposes. Once you decide where your player-missile area will be, you inform ANTIC of this by storing the page number of PMBASE into the PMBASE register in ANTIC.

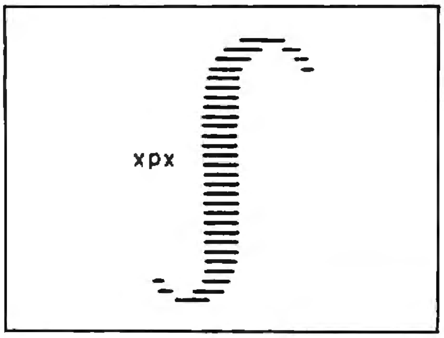

Figure 4: *Use of a player as a special symbol. This can be done because players and missiles are superimposed over whatever text or graphics are in effect.*

The next step is to clear the player and missile areas by storing zeros into all locations in the player-missile memory area. Then draw the players and missiles by storing image data into the appropriate locations in the player-missile area.

Next, set the player parameters by setting the player color, horizontal position, and width registers to their initial values. If necessary, set the player/playfield priorities. Inform ANTIC of the vertical resolution desired by setting bit D4 of register DMACTL (shadowed at SDMCTL) for single-line resolution and clearing the bit for double-line resolution. Finally, enable the players by setting the appropriate bits in DMACTL. Be careful not to disturb the other bits in DMACTL. A sample BASIC program for setting up a player and moving it with the joystick is given in listing 2.

Once players are displayed, they can be difficult to remove from the screen because the procedure by which they are displayed involves several steps. First, the ANTIC integrated circuit retrieves player-missile data from the player-missile area RAM (if such retrieval is enabled in the DMACTL register). Then ANTIC ships the player-missile data to the CTIA integrated circuit (if such action is enabled in the GRACTL register). CTIA displays whatever is in its player and missile graphics registers (GRAFP0 through GRAFP3 and GRAFM). Many programmers attempt to turn off player-missile graphics by clearing the control bits in DMACTL and GRACTL. This only prevents ANTIC from sending new player-missile data to CTIA; the old data in the GRAF(X) registers *will* still be displayed. To completely clear the players, the GRAF(X) registers must be cleared after the control bits in DMACTL and GRACTL have been cleared. A simpler solution is to leave the player up, but set its horizontal position to zero. Of course, if this solution is used, ANTIC will continue to use DMA to retrieve player-missile data, wasting roughly 10,000 machine cycles (about 10 ms) per second.

Uses

Player-missile graphics allow a number of special capabilities. They are of great value in animation. They do have limitations: there are only four players and each is only 8 bits wide. If you need more bits of horizontal resolution, you can always fall back on playfield animation. But for high-speed or quick-and-dirty animation, player-missile graphics work very well.

It is possible to bypass ANTIC and write player-missile data directly into the player-missile graphics registers (GRAFP(X)) in the CTIA integrated circuit. This gives the programmer

Listing 3: *An Atari BASIC program to create a pseudoplayer with increased resolution. See the text and figure 3 for details.*

```
  1 RAMTOP=106:REM                    OS top of RAM pointer
  2 PMBASE=54279:REM                  ANTIC player-missile RAM
                                      pointer
  3 SDMCTL=559:REM                    shadow of DMACTL
  4 GRACTL=53277:REM                  CTIA graphics control register
  5 HPOSP0=53248:REM                  horizontal position register of P0
  6 PCOLR0=704:REM                    shadow of player 0 color
                                      register
  7 SIZEP0=53256:REM                  player width control register
  8 GPRIOR=623:REM                    priority control register
 10 GRAPHICS 7
 20 SETCOLOR 4,8,4
 30 SETCOLOR 2,0,0
 40 COLOR 3
 50 FOR Y=0 TO 79:REM                 this loop fills the screen
 60 PLOT 0,Y
 70 DRAWTO 159,Y
 80 NEXT Y
 90 A=PEEK(RAMTOP)-20:REM             must back up further for GR.7
100 POKE PMBASE,A
110 MYPMBASE=256*A
120 POKE SDMCTL,46
130 POKE GRACTL,3
140 POKE HPOSP0,100
150 FOR I=MYPMBASE+512 TO MYPMBASE
    +640
160 POKE I,255:REM                    make player solid color
170 NEXT I
180 POKE PCOLR0,88
190 POKE SIZEP0,3:REM                 set player to quadruple width
200 POKE GPRIOR,4:REM                 set priority
210 COLOR 4
220 FOR Y=30 TO 40
230 PLOT Y+22,Y
240 DRAWTO Y+43,Y
250 NEXT Y
```

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more direct control over player-missile graphics. As a result, it also increases his or her responsibilities. The programmer must maintain a bit-map of the player-missile data and move it into the graphics registers at the appropriate times. The 6502 must therefore be slaved (ie: synchronized to and triggered by) to the screen drawing cycle. This is a clumsy technique that offers minor performance improvements in return for major programming efforts. The programmer who bypasses the hardware power offered by ANTIC must make up for it with his or her own sweat.

Player-missile graphics offer many capabilities in addition to animation. Players are an excellent way to increase the amount of color in a display. The four additional color registers provided allow four more colors on each line of the display. Of course, the 8-bit resolution does limit the range of their application.

There is a way around this limitation that can sometimes be used. Take a player at quadruple width and put it onto the screen. Then set the priorities so the player has lower priority than a playfield color. Next, reverse that playfield color with background, so the apparent background color of the screen is really a playfield color. The player disappears behind this new false background. Cut a hole in the false background by drawing true background on it. The player will show up in front of the true background color, but only in the area where true background has been drawn. In this way, the player can have more than 8 bits of horizontal resolution. A sample program for doing this is given in listing 3. This program produces the display shown in figure 3.

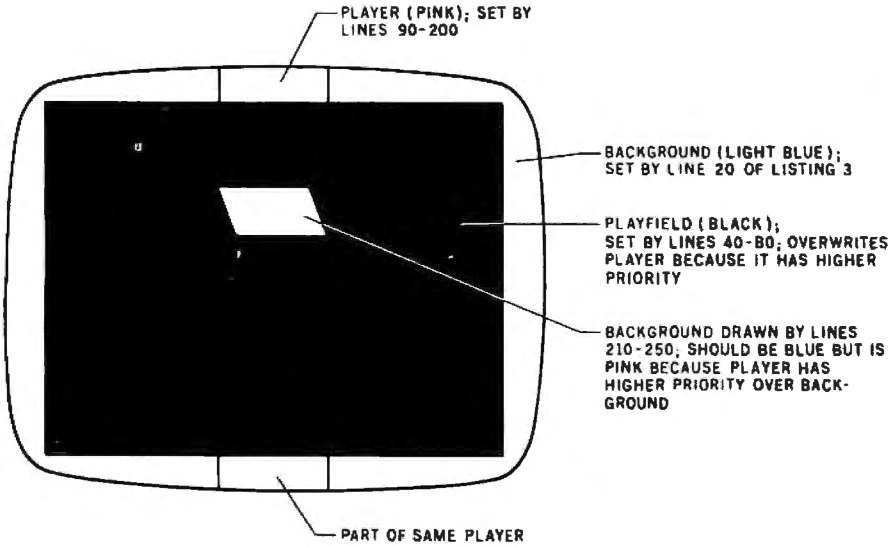

Figure 3: *Playing tricks with the video display to achieve higher player resolution. This technique works by manipulating the relative priorities of the playfield, players, and background. See the text and listing 3 for details.*

Listing 4: *An Atari BASIC program to create a player in the shape of an integral sign. See figure 4.*

```
  1  RAMTOP=106:REM                        OS top of RAM pointer
  2  PMBASE=54279:REM                      ANTIC player-missile RAM pointer
  3  SDMCTL=559:REM                        shadow of DMACTL
  4  GRACTL=53277:REM                      CTIA's graphics control register
  5  HPOSP0=53248:REM                      horizontal position register of P0
  6  PCOLR0=704:REM                        shadow of player 0 color register
 10  GRAPHICS 0:A=PEEK(RAMTOP)-
     16:REM                                must back up for 1-line resolution
 20  POKE PMBASE,A
 30  MYPMBASE=256*A
 40  POKE SDMCTL,62
 50  POKE GRACTL,3
 60  POKE HPOSP0,102
 70  FOR I=MYPMBASE+1024 TO
     MYPMBASE+1280
 80  POKE I,0
 90  NEXT I
100  POKE PCOLR0,140
110  FOR I=0 TO 15
120  READ X
130  POKE MYPMBASE+1100+I,X
140  NEXT I
150  DATA 14,29,24,24,24,24,24,24
160  DATA 24,24,24,24,24,24,184,112
170  ?" ":REM                              clear screen
180  POSITION 15,6
190  ?"x dx"
```

Another application of player-missile graphics is for special characters. There are many special types of characters that cross vertical boundaries in normal character sets. One way to deal with these is to create special character sets that address this problem. Another way is to use a player. Subscripts, integral signs, and other special symbols can be done this way. A sample program for doing this is given in listing 4. This program produces the display shown in figure 4.

A particularly useful application of players is for cursors. With their ability to smoothly move anywhere over the screen without disturbing the contents, they are ideally suited for such applications. The cursor can change color as it moves over the screen to indicate what it has under it.

Player-missile graphics provide many capabilities. Their uses for action games as animated objects are obvious. They have many serious uses as well. They can add color and resolution to any display. They can present special characters. They can be used as cursors. Use them. ■

Appendix A: Selected Hardware Registers in the Atari 400/800

Hardware Register				Shadow Register (if any)		
		Location			Location	
Symbolic Name	Function	Hexa-decimal	Decimal	Symbolic Name	Hexa-decimal	Decimal
COLBK	Color Luminance of Background	D01A	53274	COLOR4	2C8	712
COLPF0	Color Luminance of Playfield 0	D016	53270	COLOR0	2C4	708
COLPF1	Color Luminance of Playfield 1	D017	53271	COLOR1	2C5	709
COLPF2	Color Luminance of Playfield 2	D018	53272	COLOR2	2C6	710
COLPF3	Color Luminance of Playfield 3	D019	53273	COLOR3	2C7	711
COLPM0	Color Luminance of Player-Missile 0	D012	53266	PCOLR0	2C0	704
COLPM1	Color Luminance of Player-Missile 1	D013	53267	PCOLR1	2C1	705
COLPM2	Color Luminance of Player-Missile 2	D014	53268	PCOLR2	2C2	706
COLPM3	Color Luminance of Player-Missile 3	D015	53269	PCOLR3	2C3	707
DMACTL	Direct Memory Access (DMA) Control	D400	54272	SDMCTL	22F	559
GRACTL	Graphic Control	D01D	53277			
GRAFM	Graphics for all Missiles	D011	53265			
GRAFP0	Graphics for Player 0	D00D	53261			
GRAFP1	Graphics for Player 1	D00E	53262			
GRAFP2	Graphics for Player 2	D00F	53263			
GRAFP3	Graphics for Player 3	D010	53264			
HITCLR	Collision Clear	D01E	53278			
HPOSM0	Horizontal Position of Missile 0	D004	53252			
HPOSM1	Horizontal Position of Missile 1	D005	53253			
HPOSM2	Horizontal Position of Missile 2	D006	53254			
HPOSM3	Horizontal Position of Missile 3	D007	53255			
HPOSP0	Horizontal Position of Player 0	D000	53248			
HPOSP1	Horizontal Position of Player 1	D001	53249			
HPOSP2	Horizontal Position of Player 2	D002	53250			
HPOSP3	Horizontal Position of Player 3	D003	53251			
M0PF	Missile 0 to Playfield Collisions	D000	53248			
M0PL	Missile 0 to Player Collisions	D008	53256			
M1PF	Missile 1 to Playfield Collisions	D001	53249			
M1PL	Missile 1 to Player Collisions	D009	53257			
M2PF	Missile 2 to Playfield Collisions	D002	53250			
M2PL	Missile 2 to Player Collisions	D00A	53258			
M3PF	Missile 3 to Playfield Collisions	D003	53251			
M3PL	Missile 3 to Player Collisions	D00B	53259			
P0PF	Player 0 to Playfield Collisions	D004	53252			
P0PL	Player 0 to Player Collisions	D00C	53260			
P1PF	Player 1 to Playfield Collisions	D005	53253			
P1PL	Player 1 to Player Collisions	D00D	53261			
P2PF	Player 2 to Playfield Collisions	D006	53254			
P2PL	Player 2 to Player Collisions	D00E	53262			
P3PF	Player 3 to Playfield Collisions	D007	53255			
P3PL	Player 3 to Player Collisions	D00F	53263			
PMBASE	Player Missile Base Address	D407	54279			
PRIOR	Priority Select	D01B	53275	GPRIOR	26F	623
SIZEM	Sizes for all Missiles	D00C	53260			
SIZEP0	Size of Player 0	D008	53256			
SIZEP1	Size of Player 1	D009	53257			
SIZEP2	Size of Player 2	D00A	53258			
SIZEP3	Size of Player 3	D00B	53259			

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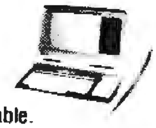

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Appendix B: Functional Specification of Selected Atari 400/800 Hardware Registers

The following charts give the functions of the registers listed in Appendix A on a bit-by-bit basis. Although this information is not necessary to the understanding of the article, it is given for the benefit of advanced programmers who want to exercise complete control over the player-missile graphics. This information is excerpted from the *Atari Personal Computer System Operating System User's Manual and Hardware Manual* (part C016555), which contains complete technical information on this and other aspects of the Atari 400 and 800 computers. This user's manual can be purchased from Atari Customer Service, 1346 Bordeaux Dr, Sunnyvale CA 94086; the price is $27 plus $3 shipping and handling (California residents must add 6½% tax).

COLBK (Background Color): This address writes data to the Background Color-Luminance Register.

Color				Luminance				
D7	D6	D5	D4	D3	D2	D1	Not Used	
X	X	X	X	0	0	0		Zero Luminance (black)
(see below)				0	0	1		
					etc			
				1	1	1		Max. Luminance (white)
0	0	0	0	Grey				
0	0	0	1	Gold				
0	0	1	0	Orange				
0	0	1	1	Red-Orange				
0	1	0	0	Pink				
0	1	0	1	Purple				
0	1	1	0	Purple-Blue				
0	1	1	1	Blue				
1	0	0	0	Blue				
1	0	0	1	Light-Blue				
1	0	1	0	Turquoise				
1	0	1	1	Green-Blue				
1	1	0	0	Green				
1	1	0	1	Yellow-Green				
1	1	1	0	Orange-Green				
1	1	1	1	Light-Orange				

Shadow Register: COLOR4

Circle 389 on inquiry card.

COLPF0—COLPF3 (Playfield Color): These addresses write data to the Playfield Color-Luminance Registers.

D7	D6	D5	D4	D3	D2	D1	D0

(see COLBK for bit assignment)

Shadow Registers: COLOR0—3

COLPM0—COLPM3 (Player-Missile Color): These addresses write to the Player-Missile Color-Luminance Registers. Missiles have the same color luminance as their player unless missiles are used as a fifth player (see bit 4 of PRIOR). A fifth player missile gets its color from register COLPF3.

D7	D6	D5	D4	D3	D2	D1	D0

(see COLBK for bit assignments)

Shadow Registers: PCOLR0—3

DMACTL (Direct Memory Access Control): This address writes data into the DMA Control Register.

Not Used	D5	D4	D3	D2	D1	D0

D5 = 1			Enable ANTIC operation (must be set to 1)
D4 = 1			1 line Player/Missile resolution
D4 = 0			2 line Player/Missile resolution
D3 = 1			Enable Player DMA
D2 = 1			Enable Missile DMA
D1,D0 =	0	0	No Playfield DMA
=	0	1	Narrow Playfield DMA (128 Color Clocks)
=	1	0	Standard Playfield DMA (160 Color Clocks)
=	1	1	Wide Playfield DMA (192 Color Clocks)

See GRACTL. Shadow Register: SDMCTL, default value hexadecimal 22

GRACTL (Graphics Control): This address writes data to the Graphic Control Register.

Not Used	D1	D0

D1 = 1 Enable Player DMA to Player Graphics Registers.
D0 = 1 Enable Missile DMA to Missile Graphics Registers.

DMA is enabled by setting bits in both DMACTL and GRACTL. Setting DMACTL only will result in cycles being stolen, but no display will be generated.

GRAFM (Missile Graphics Registers): This address writes data directly into the Missile Graphics Register, independent of DMA. This is a bit-map of the current scan line of all four missiles. It is automatically maintained by the normal use of player-missile graphics.

D7	D6	D5	D4	D3	D2	D1	D0	
L	R	L	R	L	R	L	R	
M3		M2		M1		M0		Missile Number

GRAFP0—GRAFP3 (Player Graphics Registers): These addresses write data directly into the Player Graphics Registers, independent of DMA. This is a bit-map of the current scan line for a given player. It is automatically maintained by the normal use of player-missile graphics.

D7	D6	D5	D4	D3	D2	D1	D0
Left							Right

Player on TV Screen

Circle 290 on inquiry card.

HITCLR (Collision "HIT" Clear): Writing to this address clears all collision bits in all the collision registers.

Not Used

HPOSM0—HPOSM3 (Missile Horizontal Position): These addresses write data into the Missile Horizontal Position Registers (see HPOSP0 description below).

D7	D6	D5	D4	D3	D2	D1	D0

HPOSP0—HPOSP3 (Player Horizontal Position): These addresses write data into the Player Horizontal Position Register. The horizontal position value determines the color clock location of the left edge of the object. Hexadecimal 30 is the left edge of a standard-width screen. Hexadecimal D0 is the right edge of a standard-width screen.

D7	D6	D5	D4	D3	D2	D1	D0

M0PF, M1PF, M2PF, M3PF (Missile-to-Playfield Collisions): These addresses read missile-to-playfield collisions. A 1 bit means that a collision has been detected since the last HITCLR.

Not Used (forced to zero)	D3	D2	D1	D0	
	3	2	1	0	Playfield Type

M0PL, M1PL, M2PL, M3PL (Missile-to-Player Collisions): These addresses read missile-to-player collisions.

Not Used (forced to zero)	D3	D2	D1	D0	
	3	2	1	0	Player Number

P0PF, P1PF, P2PF, P3PF (Player-to-Playfield Collisions): These addresses read player-to-playfield collisions.

Not Used (forced to zero)	D3	D2	D1	D0	
	3	2	1	0	Playfield Type

P0PL, P1PL, P2PL, P3PL (Player-to-Player Collisions): These addresses read player-to-player collisions.

Not Used (forced to zero)	D3	D2	D1	D0	
	3	2	1	0	Player Number

(Player *n* against player *n* is always a zero.)

PMBASE (Player-Missile Address Base Register): This address writes data into the Player-Missile Address Base Register. The data specify the most-significant bits of the address of the beginning of the player-missile area.

One-Line Resolution

D7	D6	D5	D4	D3	not used	
						PMBASE

Two-Line Resolution

D7	D6	D5	D4	D3	D2	not used	
							PMBASE

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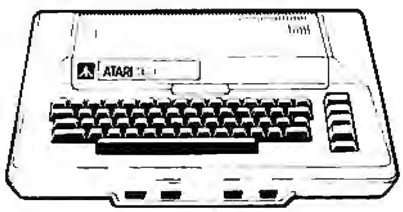

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PRIOR (Priority Register): This address writes data into the Priority Control Register.

D7	D6	D5	D4	D3	D2	D1	D0

D7—D6 Set to zero.
D5 *Multiple Color Player Enable* This bit set to 1 causes the logical "or" function of the bits of the colors of Player 0 with Player 1, and also of Player 2 with Player 3. This permits overlapping the position of two players with a choice of three colors in the overlapped region.
D4 *Fifth Player Enable* This bit causes all missiles to assume the color of Playfield Type 3. (COLPF3). This allows missiles to be positioned together with a common color for use as a fifth player.
D3—D0 *Priority Select* Only one of these 4 bits can be a 1. These bits select one of four types of priority. Objects with higher priority will appear to move in front of objects with lower priority.

Higher Priority ↑	D3 = 1	D2 = 1	D1 = 1	D0 = 1
	PF0	PF0	P0	P0
	PF1	PF1	P1	P1
	P0	PF2	PF0	P2
	P1	PF3 + P5	PF1	P3
	P2	P0	PF2	PF0
	P3	P1	PF3 + P5	PF1
	PF2	P2	P2	PF2
	PF3 + P5	P3	P3	PF3 + P5
	BAK	BAK	BAK	BAK

P*n* = player *n*
PF*n* = playfield *n*
BAK = background
\+ = logical *or* (PF3 and P5 ar
always same color)

Note: The use of priority bits in a "nonexclusive" mode (more than one bit set to 1) will result in objects whose priorities are in conflict turning *black* in the overlap region.

Example: PRIOR code = 1010: This will black out P0 or P1 if they are over PF0 or PF1. It will also black out P2 or P3 if they are over PF2 or PF3. In the one-color 40-character (playfield) modes, the *luminance* of a pixel in a character is determined by COLPF1, regardless of the priority. If a higher-priority player or missile overlaps the character, the *color* is determined by the player's color.

Shadow Register: GPRIOR

SIZEM (Missile Size): This address writes data into the Missile Size Control Register.

Horizontal Size Register (Missile)

D7	D6	D5	D4	D3	D2	D1	D0
M3		M2		M1		M0	

D1	D0	
0	0	Normal Size (total of 2 color clocks wide)
0	1	Twice Normal Size (total of 4 color clocks wide)
1	0	Normal Size
1	1	Four Times Normal Size (total of 8 color clocks wide)

SIZEP0—SIZEP3 (Player Size): These addresses write data into the Player Size Control Registers.

Horizontal Size Register (Player)

Not Used	D1	D0	
	0	0	Normal Size (total of 8 color clocks wide)
	0	1	Twice Normal Size (total of 16 color clocks wide)
	1	0	Normal Size
	1	1	Four Times Normal Size (total of 32 color clocks wide)

With normal-size objects, each bit in the graphics register corresponds to one color clock. This makes an 8-bit wide player 8 color clocks wide. For larger objects, each bit is extended over more than one color clock.

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Whatever its merits or demerits, BASIC is the language most used by microcomputer programmers. Microsoft's excellent implementation of BASIC is one of the reasons the TRS-80 Model I is the most popular microcomputer today. Most of us note the absence of some particular feature (I would like to have matrix functions), but everyone's needs are different. I was, therefore, skeptical about the usefulness of an enhancement package for TRS-80 BASIC.

I am no longer a skeptic. ENHBAS (pronounced *en-base*), written by Philip A Oliver and sold by the Cornsoft Group, provides useful new functions, statements, and commands, and greatly improves the operating environment by providing keyboard, video, and audio enhancements. This software is designed for the TRS-80: it is not rewarmed and reworked from some other system. And ENHBAS makes programming much more enjoyable. In terms of packaging, documentation, ease of use, lack of bugs, and overall quality of design, ENHBAS is the best software package I have seen for the TRS-80, and that *includes* Microsoft's BASIC compiler, NEWDOS/80, VTOS, and Scripsit. With the release of this product, a small company and a single author have entered the big league in quality software.

ENHBAS resides in about 4 K bytes of RAM. It provides new keyboard, printer, and video drivers and a variety of new commands, statements, and functions. The drivers give a user-definable cursor, clicks when keys are pressed, true control characters, distinctive tones for error and break, single-key entry for such things as PRINT and INPUT, a lowercase driver, and a variety of other features. The printer driver even senses whether or not a printer is on line, waits six seconds for the printer to be turned on, and if it isn't, gives an error message and returns without "hanging" the system. If a BASIC program is NEWed or even if the system is booted, simply typing RENEW after bringing BASIC back up will usually restore the program. That means no more program loss after accidental reboots. The new statements are described below in detail, and they include new graphics, branching, screen control, sorting, printer formatting, and more.

Two smaller versions, ENHSORT and ENHGRAPH, are also available at $24.95 each. They support ENHBAS sorting routines and graphics routines, respectively. Programs written for these versions are upward compatible with ENHBAS.

ENHBAS is available for Models I, II, and III. The Model III package is nearly identical to that for the Model I, and there are disk and tape versions for both. The tape version provides all of the functions of disk BASIC except file manipulation functions and multiple USR routines. There are also many additional enhancements for the Model II, but since I used the disk-based Model I system, I'll only mention a few of those features.

Initialization and Loading

The disk version of ENHBAS comes on a special disk that is copy-protected and has its own tiny operating system. You put the disk in drive 0 and boot the system. After a prompt, you place a TRSDOS or NEWDOS 2.1 disk in the drive, and a 32 K or 48 K version of ENHBAS/CMD is dumped to that system disk.

At a Glance

Name
ENHBAS

Type
Enhanced operating environment and BASIC language

Manufacturer
The Cornsoft Group
6008 N Keystone Ave
Indianapolis IN 46220
(317) 257-3227

Price
$59.95 (Model I or III), $99.95 (Model II)

Format
Tape, 5- or 8-inch disk depending on computer

Computer
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Audience
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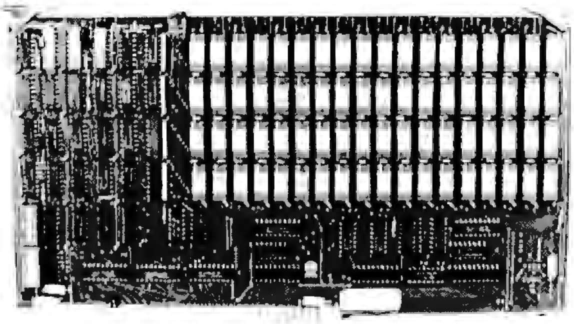

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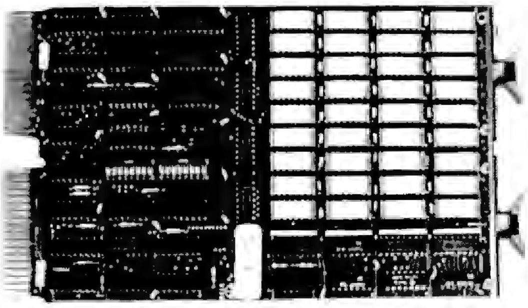

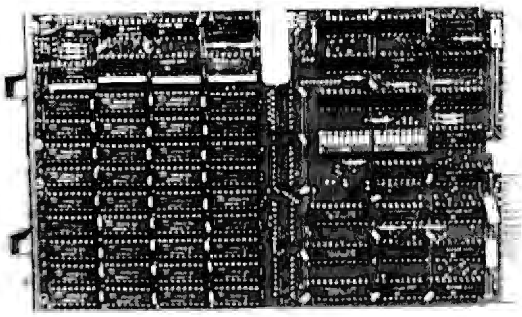

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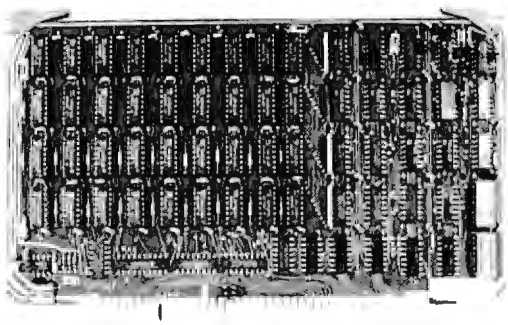

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The initialization software automatically senses the size of the system. For use with NEWDOS/80, the program must be copied from the NEWDOS 2.1 or TRSDOS disk. The author has assured me that the software is compatible with all currently available operating systems that use the TRSDOS disk format. In all, the original initialization takes about three minutes, and the original disk is needed again only if the ENHBAS/CMD program is somehow lost.

Use of the new program is just as simple. Typing ENHBAS <ENTER> loads and initializes the package, protects a section of upper RAM (random-access read/write memory), and brings up BASIC. The memory size, file number, and program loading and running conventions are the same as before for the operating system being used, but they follow the ENHBAS command instead of BASIC. A return to command level leaves the new drivers intact. All the appropriate features are available in DOS (disk operating system) mode or during use of any /CMD program that doesn't have its own drivers (sadly, Scripsit does). The only incompatible programs I have found are the DSET and DBLFMT commands in Software Etc's implementation of double density for NEWDOS/80, but these present trivial problems that are easily circumvented. BASIC can be reentered just as before.

Typing ENHBAS again will lock up the system, which was one of the few faults that I found; it would be nice to be able to disable ENHBAS without rebooting. Since you will almost always want ENHBAS in the system, it's most easily initialized by a CHAIN command if your operating system has such a feature. Listing 1 shows a NEWDOS/80 double-density chain file that does the initialization and reenters DOS. A file for use with ComProc or other DOSes would be similar. The tape system is initialized by typing SYSTEM; typing ENHBAS after the prompt then loads and initializes the tape.

Listing 1: *A CHAIN file for use with NEWDOS/80 and the Percom Doubler to load and initialize ENHBAS. ADR disables and enables automatic recognition of double density. The POKE at line 40 enables control-H to sound the bell; the POKE at line 50 changes the cursor character. PAGE and CLM set page length and number of characters per line. Removal of ADR allows it to be used with NEWDOS/80 version 2.0.*

```
10    OPEN"O",1,"ENHBAS/JCL"        OPEN THE CHAIN FILE
20    PRINT #1, "ADR OFF"          AUTO DENSITY RECOGNITION OFF
30    PRINT #1, "ENHBAS"            INITIALIZE
40    PRINT #1, " POKE 16409,1"    'ENABLE THE BELL
50    PRINT #1, " POKE 16419,127"  'CHANGE THE CURSOR
60    PRINT #1  " PAGE=55"          PAGE LENGTH
70    PRINT #1, " CLM=132"          COLUMN WIDTH
80    PRINT #1, " CMD";CHR$(34),"S";CHR$(34)  RETURN TO DOS
90    PRINT #1, "ADR ON"           'AUTO DENSITY RECOGNITION ON
100   CLOSE
```


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Listing 2: *ENHBAS's sort functions in action. The program in listing 2a, which produces the output in listing 2b, displays four arrays five times each. First they appear unsorted, then sorted according to the different keys and tags noted in the program's remarks.*

(2a)

```
10      CLEAR 200'DEFINT A-Z
20      DIM A(20),B$(20),C(20),D$(20)
30      LPRINT "A(X)","B$(X)","C(X)","D$(X)"  PRINT HEADERS
40      LPRINT STRING$ (55,"#")
50      FOR I=1 TO 5 'SET UP ARRAYS AS RANDOM NUMBERS AND LETTERS
60      A(I)=RND(5)  B$(I)=CHR$(70+RND(5)). C(I)=RND(999)  D$(I)=CHR$(80+RND(10)
70      NEXT I
80      CSUB "PNT"  PRINT THE ORIGINAL RANDOM ARRAYS
90      SCLEAR   CLEAR FOR THE SORT
100     KEY A '  SORT ON INTEGER ARRAY A, ASCENDING
110     ATOP=5   USE ONLY THE FIRST FIVE ELEMENTS
120     SORT - DO THE SORT!
130     CSUB "PNT"   PRINT THE RESULTS
140     SCLEAR   CLEAR FOR THE NEXT SORT
150     ATOP=5   FIRST FIVE ELEMENTS ONLY
160     KEY C   SORT ON INTEGER ARRAY "C"
170     TAG A   FORCE THE ELEMENTS OF ARRAY "A" TO FOLLOW "C"
180     SORT   DO THE SORT
190     CSUB "PNT" ' PRINT THE RESULTS
200     SCLEAR   SET UP FOR THE NEXT SORT
210     ATOP=5   FIRST 5 ELEMENTS ONLY
220     KEY C,B$ - PRIORITY SORT ON B$, NEXT ON ARRAY C(X)
230     TAG A,D$   FORCE ARRAYS A AND D$ TO FOLLOW C AND B$
240     SORT   SORT THEM
250     CSUB "PNT"   PRINT THE SORT RESULTS
260     SORT (1)   DO A DESCENDING SORT
270     CSUB "PNT" ' PRINT THE RESULT
280     LPRINT CHR$(12)
290     END
500     UNAME "PNT"- PRINTING SUBROUTINE
510     FOR I=1 TO 5
520     LPRINT A(I),B$(I),C(I),D$(I)
530     NEXT I
540     LPRINT STRING$ (55,"#")
550     RETURN
```

(2b)

```
A(X)            B$(X)           C(X)            D$(X)
#######################################################
 1              G               577             S
 5              J               649             R
 3              I               874             Y
 5              K               972             V
 1              J               429             W
#######################################################
 1              G               577             S
 1              J               649             R
 3              I               874             Y
 5              K               972             V
 5              J               429             W
#######################################################
 5              G               429             S
 1              J               577             R
 1              I               649             Y
 3              K               874             V
 5              J               972             W
#######################################################
 5              G               429             S
 1              I               649             Y
 1              J               577             R
 5              J               972             W
 3              K               874             V
#######################################################
 3              K               874             V
 5              J               972             W
 1              J               577             R
 1              I               649             Y
 5              G               429             S
#######################################################
```

The Operating Environment

The first thing you notice after initialization is that the cursor is now a block (this can be changed to any character by a single POKE, which is handy for letting the cursor tell you where you are in a complex program). If an amplifier is connected to the tape output, pressing a key will produce a "click" (really a very short beep). This gives a professional feel to the keyboard and it's a nice feature for those of us who are touch typists; it's something I have longed for in Scripsit. Pressing BREAK produces a different tone, and an error produces a two-tone signal. If PRINT CHRS$(8) (ASCII bell) is in a program, Westminster chimes sound!

The CLEAR key is redefined as a true control (sometimes abbreviated as *ctrl*) key. You clear the screen by using control-@. Most of the control characters do nothing in the normal TRS-80, but control-H produces a backspace, control-G sounds Westminster chimes, control-C is a break (with an echo of a down-arrow and C to the screen, which BREAK also does), control-A is a break without echo, control-I is a tab, and control-J is a linefeed with carriage return. Using the control key with numerals 1 through 6 produces special characters if lowercase is installed, control-dash gives an underline, and control-arrows puts arrows on the screen.

Four one-letter direct commands are available (similar to NEWDOS). E, R, L, and D produce EDIT, RUN, LIST, and DELETE, respectively. Similarly, single-key abbreviations are available for 35 different BASIC commands, statements, and functions by simultaneously pressing the shift key, the clear key, and the abbreviation key. Shift-clear and A produces AUTO, shift-clear and P produces PRINT, shift-clear and N produces NEXT, shift-clear and D produces DIM, and so on. I find this of little value except with the most commonly used words; otherwise it's quicker to type the word than to look it up, even if the keys are labeled. But some people may find more of these single-key abbreviations useful.

Another nice feature is formatting of program listings. The printer driver indents text by six spaces as shown in listing 2; this makes listings easier to read, and the feature works for video output as well. I've already mentioned the user-definable cursor and the ability to sense whether or not the printer is available. These enhancements of the operating environment seem to me practically worth the cost of the entire package. But they are only a minor part of ENHBAS. The main features are the enhancements to the BASIC language itself.

Language Enhancements

Programming enhancements can be divided into commands, statements, and functions. In all, 33 have been added to the language (as compared to about 85 originally available in the Microsoft Level II BASIC and about 40 added by TRSDOS), although sev-

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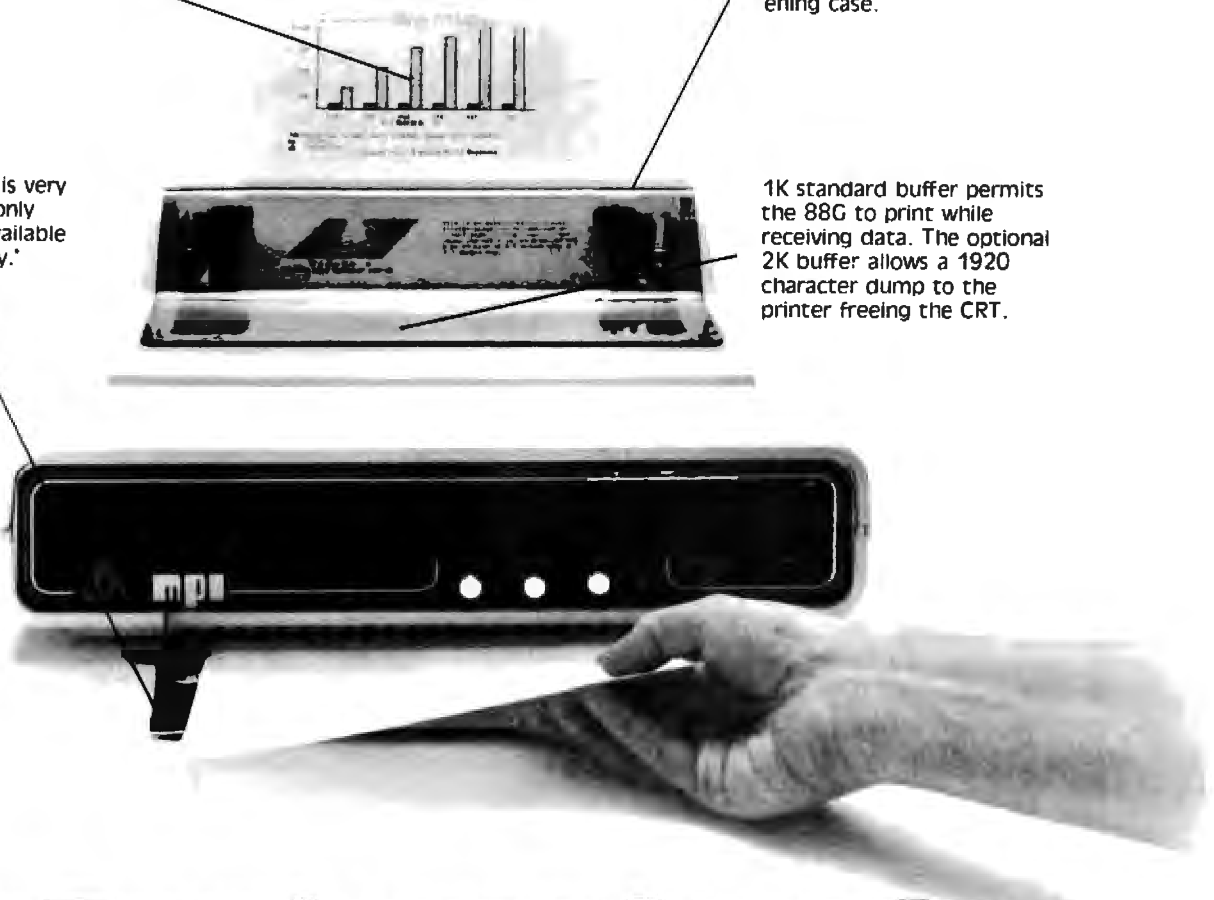

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eral are interrelated. We'll look at the added commands and functions one by one. Most of the statements can be divided among those that control sorting, branching, graphics, screen displays, and printer formatting.

There are two new commands: RENEW and FIND. RENEW, which has already been described, is one of the most useful of ENHBAS's features, since it almost always allows recovery of a BASIC program unless there has been an attempt to overlay the BASIC memory area or a loss of power. It's even possible to leave BASIC, execute DOS commands, then reenter BASIC and bring the old program back. FIND locates a part of a program that has been labeled using the JNAME statement (described with the new branching statements below). FIND makes it possible to label a line with a name and then branch to the name rather than the line number. Since FIND locates the branching label, subroutines and branching points may each be named and easily located. All who have suffered with improperly commented subroutines will appreciate this feature.

Sorting

The sorting routines are based on a modified Shell-Metzner technique and handle ascending and descending numeric and string sorts. These sorting routines were the inspiration for ENHBAS, since the whole thing grew out of the development of a machine-language sorting project. The sort routines are easy to set up (at least if you're used to machine-language sorts such as Racet's GSF). Only five statements are required (SCLEAR, KEY, TAG, SORT, and ATOP). It is possible to key and tag several arrays. A sort should usually be preceded by the statement SCLEAR (really a function), and then the variables to be sorted are set up using KEY (the variables may be alphabetic or numeric and are stored in an array). Thus:

```
120 KEY AGE, NAME$
```

would set up a sort in line 120 so that a string array NAME$(x) would be sorted with top priority, and if there were duplicate entries they would be sorted by order using the numeric array AGE(x). Using KEY, you can set sorting priorities for up to fourteen different arrays. You usually want a sort to carry along another variable with the sorted elements, and TAG allows that. Thus a sort by names could carry addresses along with the names. For example:

```
130 TAG ADDR$, ZIP
```

following line 120 would force the addresses in array ADDR(x) and the zip codes in array ZIP(x) to tag along after the names and ages as they were sorted by the KEY specification in line 120. Up to fourteen arrays can tag along in the sort. The statement SORT (f) actually forces the sort. The "f" is a flag that specifies if the sort should arrange the elements from small to large or large to small. SORT (0) (or simply SORT) produces a sort in ascending order, from smallest to largest. SORT (1) does a descending sort, with the largest elements coming first. A sort will actually process all the elements dimensioned in an array, whether they have been assigned values or not (the arrays must be of equal length). When you don't need all the elements in an array, you can specify the upper limit. If we added

```
140 ATOP=(12)
```

to the previous statements, this statement would limit the sort to the first twelve array elements. The short program in listing 2 illustrates the sort procedure and its output. The sorts are very fast: 500 integers can be sorted in less than four seconds.

Branching

ENHBAS provides three new types of branching options. These are branching to labels and variables, selective restoring of DATA statements (that is, the data pointer can be restored to something other than the initial data element), and conditional looping using the WHILE/

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WEND construct. The labeled branching enhancement uses the statements JNAME, GTO, and CSUB. JNAME places a label in a line. In listing 2, for example, the JNAME "pnt" labels the subroutine "pnt". JNAME must be the first statement in a line, and it cannot be followed by REM without a colon first; an apostrophe (') may be used, but there must never be a space after the label (despite an example to the contrary in the documentation). Labeled subroutines make programs much more readable and, of course, avoid the possibility of incorrect branching caused by changing the number of a subroutine's first line. Branching to labels also enables you to move subroutines around without worrying about losing track of them in the calling statements.

The use of labeled subroutines requires two new calling statements. GTO and CSUB (for call subroutine) are used exactly like GOTO and GOSUB except that they call a routine labeled in a JNAME statement. GTO and CSUB can also call a line number defined by variable. For example, GTO X*100 with a value for X of 5 would force a branch to line 500.

This allows conditional branching according to whether a condition is "true" or "false." The FIND command, mentioned above, lets you locate a line previously labeled using JNAME by simply typing FIND (name); FIND "PNT" would locate that subroutine in listing 2, although FIND would normally be used with much more complex programs.

The WHILE and WEND statements go a long way toward making BASIC a structured language. They are used in the same way WHILE and WEND are used in more extended Microsoft BASICs, such as the BASIC compiler for the TRS-80. WHILE a condition is "true," WEND placed at the end of a loop will send execution back to the WHILE statement. Thus the short program:

```
10 X=0
20 WHILE X< =8;
30 PRINT X
40 X=X+1
50 WEND
```

will have the same effect as:

```
10 FOR X=1 TO 8
20 PRINT X
30 NEXT X
```

Although the former program is longer, in a less trivial example it forces much better programming practice and a more logical program flow. Conditional loops of this sort are one of the reasons many consider Pascal a superior programming language. Note that a semicolon is needed at the end of the WHILE statement; this contrasts with the WHILE construct used by Microsoft.

RDGOTO and RDGTO both do the same thing, except that the latter statement uses the label and variable conventions of CSUB and GTO. In "normal" BASIC, the command RESTORE after reading from DATA statements sends the read pointer back to the first data element. RDGOTO sends it back to a particular line number, so that material may be read from the middle of a data list. RDGTO lets the line be specified by a variable (see the example for GTO given above). I don't

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often use DATA statements, so I can't get excited about this, but I can see that it would be useful in some applications.

Graphics

The new graphics statements are both fun and useful. Although there are only three, PLOT, DRAW, and INVERT, they do a lot. The simplest, INVERT, is really a command. It simply changes each graphics point from on to off, producing a black-on-white effect. Graphics blocks occupied by characters are unaffected.

PLOT is useful for data output. Recall that any graphics point on the screen can be referenced by x and y coordinates. For example, SET(22,33) turns on a point at the x coordinate 22 and the y coordinate 33. PLOT has the construct:

PLOT (flag),x1,y1 TO x2,y2

Thus,

PLOT S,22,33 to 55,44

(which uses the S flag to set points to white) would draw a line between points 22,33 and 55,44. Using the flag R resets the points to black (ie: it "turns off the lights" along a line). PLOT can also be used to draw a rectangle on the screen if the flag is set as SB (set box). Thus,

PLOT SB, 10,10 TO 30,30

would draw a box with its upper left corner at 10,10 and its lower right corner at 30,30. The flag RB is similar, except it turns off the graphics points. Here's a simple exercise. Can you figure out what

CLS: INVERT:PLOT RB,10,10 TO 30,30

would do? (Hint: It would produce a "black on white" figure.)

CLS: PLOT SB,10,10 TO 30,30: INVERT

would do the same thing.

DRAW is more complex, but basically it allows vector graphics on the TRS-80 screen. Vector graphics can be likened to drawing a line with a pencil that moves in short increments. A previously filled array specifies the direction and the number of increments the pencil should move each time it moves. [*This is similar to* shape tables *used to draw graphic shapes on the Apple II....*GW] The structure of the statement is:

DRAW (flag), @ x,y USING (vector array)

The flags are S or R, with the same meaning as for PLOT, and x and y are the starting point of the line to be drawn. Thus,

DRAW S, @ 30,30 USING A

Listing 3: *A vector-graphics program using ENHBAS's DRAW and PLOT statements. The additional ENHBAS command INVERT is used to achieve a black-on-white effect. (The output of this program is shown in photo 1.)*

```
10     DEFINT A-Z
20     DIM A(25)
30     POKE 16426,1                'SET THE PLOT SCALE
40     POKE 16427,2                'SET THE PLOT ROTATION
50     FOR J=1 TO 3                'FILL AN INDEX ARRAY
60       FOR I=0 TO 7               TO SPECIFY THE PLOT
70         A=256*J+I+1                    "
80         IF I=7 THEN A=A+256            "
90         A((J-1)*8+I)=A                 "
100      NEXT I                           "
110    NEXT J                             "
120    A(22)=0                            "
130    CLS
140    FOR X=1 TO 8                'ROTATE THRU 8 TURNS
150      FOR Y=0 TO 2              'AND DO 3 DIFFERENT PLOTS
160        POKE 16426,X             THIS DOES THE ROTATE
170        DRAW SET @ 23+40*Y,23 USING A 'THIS DRAWS THE FIG.
180      NEXT Y
190    NEXT X
200    PLOT SB, 3,2 TO 124,45   THIS DRAWS A BOX AROUND THE FIG
210    INVERT                  'AND THIS MAKES IT BLACK ON WHITE
220    PRINT CHR$(7);           THIS PLAYS A WESTMINSTER CHIMES
230    GOTO 230
```

Circle 105 on inquiry card.

would produce a complicated line starting at the point 30,30 and using the directions and lengths specified in the array "A". The complications occur in setting up the array. Listing 3 is a short vector-graphics program; photo 1 shows its results. The length of the increments (which specifies the scale of the drawing) and the rotation of the drawing can also be controlled by poking values into two locations in memory (see listing 3). One limitation of the vector graphics used here is that the direction of movement of the "pencil" can be specified only in 45-degree increments.

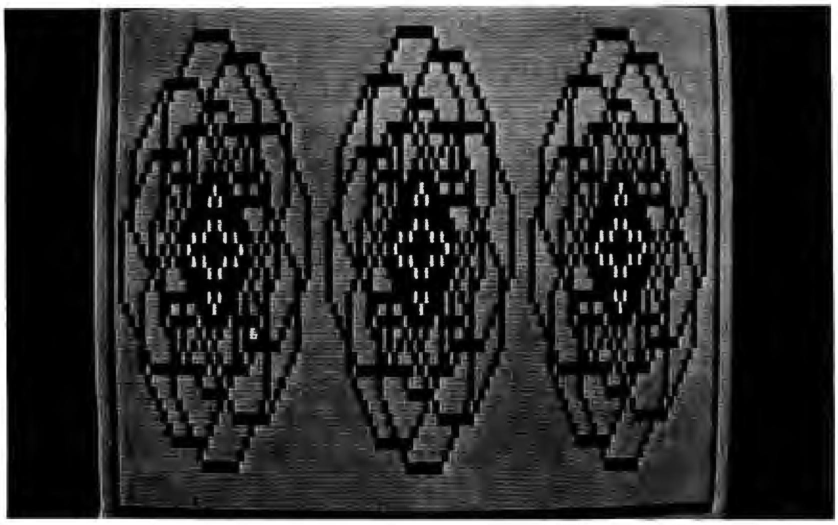

Photo 1: *The output from the simple vector-graphics program given in listing 3. ENHBAS's DRAW, PLOT, and INVERT statements make it easy to program these graphics.*

Screen Control

The first of the screen-control statements, LEFT, is really a command and is most useful in graphics. Its action is simple: it moves everything on the screen one character to the left. This is useful for moving graphs. For example, a sine wave might be drawn onto the screen using SET, and if LEFT were used each time a SET was done the sine wave would travel across the screen. Moving bar graphs and fancy moving graphics are also possible, especially if you combine LEFT with DRAW.

SCROLL produces professional-looking output: it splits the screen into two sections, protecting the upper section from scrolling while allowing the lower to scroll in the usual way. SCROLL is enabled by the statement SCROLL=SET, which also clears the screen. SCROLL=4, for example, then prevents the upper four lines from scrolling; they will stay in place during a listing or output from a program. SCROLL=RESET disables the scroll-protect feature. I like to use this feature when modifying programs by using it in the command mode. I can "lock" a few program lines on the upper screen and use the lower for modifications and listings. Simply typing SCROLL=RESET then brings me back to the normal mode. The screen-clearing feature can be annoying; I would prefer to be able to control clearing separately by using CLS.

Printer Formatting

The two printer-formatting statements are simple but valuable. CLM (integer) sets the maximum column width (in characters) before a wraparound. This is necessary on printers that truncate the end of a line, and useful on others. I use a 14½-inch-wide printer format, and CLM lets me specify that the output would be narrower, thus allowing narrower paper for some applications. The default column width is 80 characters, which surprised me when I first listed a program with long lines.

The command PAGE (number) specifies the number of lines that will be printed on each page. When the

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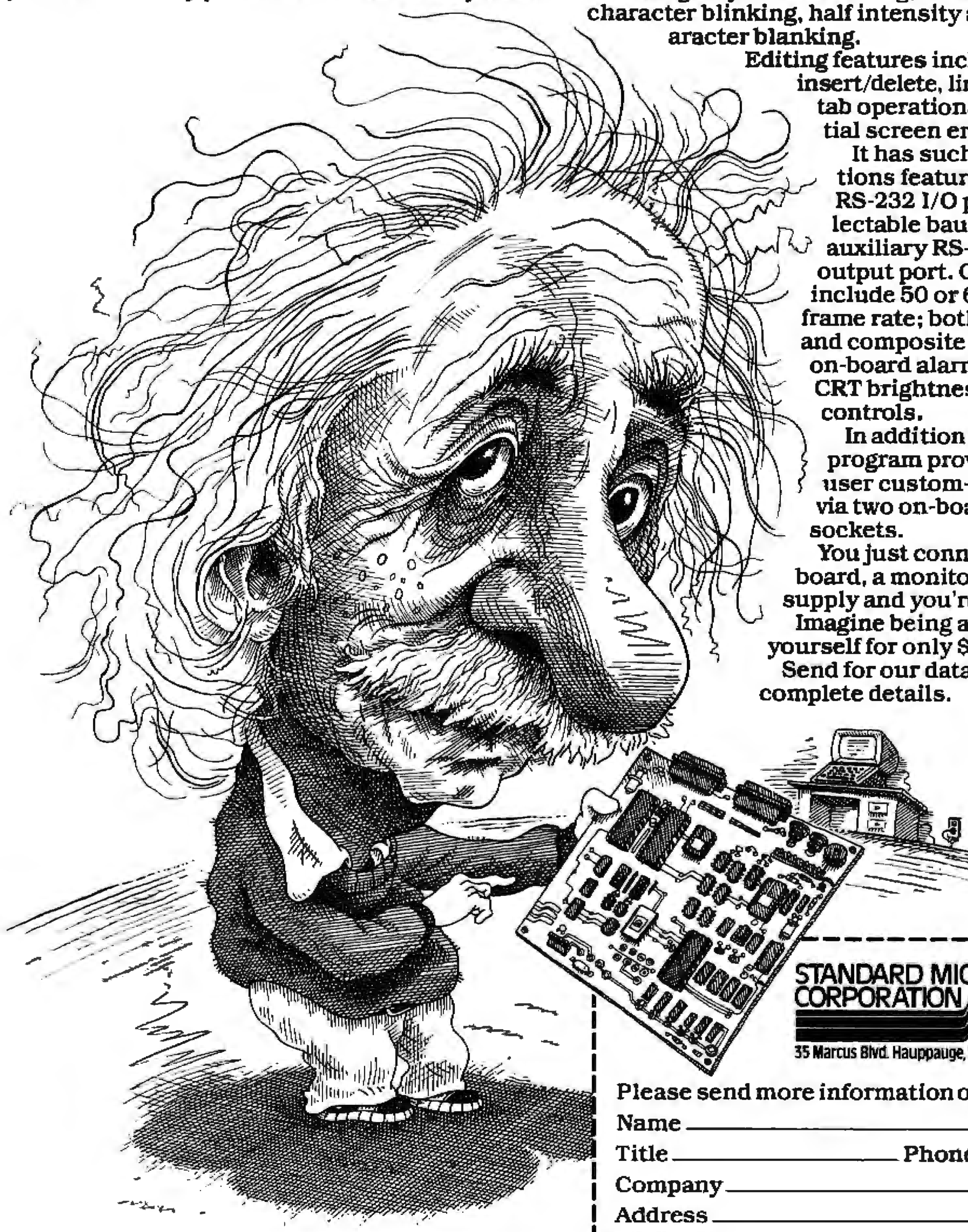

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lines have been printed, the TRS-80 sends blank lines until the top of the next page is reached. Each page is assumed to have a total of 66 lines, printed and blank; if your printer has a different page length, you can change the default by POKEing the correct number in location 16424. Immediately after turning on the computer, I normally set PAGE (at 55) and CLM (at 132) by using a CHAIN file in NEWDOS/80 (see listing 1).

Other Features

ENHBAS has many other useful statements and related functions. By far the most powerful of these is EXEC (string), which executes a string as a program statement. For example:

```
A$="Y=X+2*SIN(X)":EXEC A$
```

executes the statement Y=X+2*SIN(X). Using EXEC, you can define statements as strings and repeatedly execute the statements in the program. This can eliminate a lot of GOSUB s to short subroutines. You can also construct statements using string manipulation and then execute them. In theory it is even possible to write a BASIC program that will write another program.

A similar routine is EVAL, although it is really a function rather than a statement. The statement

```
EVAL (string)
```

evaluates a string as if it is an algebraic expression. Thus:

```
A$="X+2*SIN(X)":Y=EVAL(A$)
```

does the same thing as the example in the previous paragraph. As with EXEC, you can have the program manipulate the strings. As an example of an application for teaching programs, a student can enter a function as a string, and that function could then be evaluated, plotted, etc. I have by no means explored all of the uses of EVAL and EXEC, but they seem to offer a host of possibilities in instructional programs and even a variety of artificial intelligence.

Another miscellaneous statement is POP. POP allows a graceful exit from a subroutine before its end is reached. Suppose a subroutine at line 200 calls another at line 400. A normal branch out of the second subroutine would mean that the next RETURN would bring the program to the point where the second was called in the first subroutine. If POP has been executed, however, the "return to 200" would be eliminated and execution would be returned to the main program. This is similar to the EXIT command in some other BASICs. Usually POP is used with some kind of IF statement or other conditional branch.

WPOKE and WPEEK place and retrieve 16-bit integer values to and from memory. For example, WPOKE (28560), 2992 pokes the integer value 2992 into location 28560 and 28561 (2 bytes are needed to store an integer). WPEEK (28560) then retrieves the number. PRINT WPEEK (16561) returns the memory size that had been set on entering BASIC, for example. WPEEK can be particularly useful in conjunction with VARPTR.

The simplest of the new functions (including WPEEK and EVAL, which have already been described) are PI and EN. PI simply returns the value of π, and EN the value of the exponential constant e (the base of natural or Napierian logarithms). Either single or double precision is returned, depending on the precision of the assignment variable. A!=PI would set A! to 3.14159, while A#=PI would give A# the value of 3.141592653589793.

BIN$ and HEX$ return a string that expresses the binary or hexadecimal value of an integer. A$=BIN$(10432) assigns "0010100011000000" to A$; A$=HEX$(10432) assigns "28C0". I wondered why such functions weren't included in disk BASIC. Now I wonder why a function OCT$ wasn't included in ENHBAS.

SIZE is the simplest function or statement in this whole package. It returns the length (in bytes) of the resident program, in the same way that MEM returns the remaining memory; three years ago I thought a similar function should have been a part of Level I BASIC.

WINKEY$ is another function that should have been a part of an earlier version of the TRS-80 BASICs. Although similar to INKEY$ in that it takes a value from the keyboard without waiting for ENTER to be pressed, WINKEY$ waits until there is an input. While INKEY$ must be put into a sometimes complex loop structure, WINKEY$ can stand alone. This results in code that is shorter and easier to read and allows some input structures that were, previously, nearly impossible. BASIC is probably the consumate interactive language, and WINKEY$ is a function that makes interaction even easier.

PLAY (string) sends a sequence of tones to the cassette port. The first byte of the string specifies the tone and the second and third the duration; this sequence is repeated, 3 bytes at a time, to specify a tune. While it is possible to write simple melodies this way, it isn't easy. The tones are not linear functions of the byte values, and the actual duration depends not only on the two duration bytes but also on the tone value. Thus, writing a tune is a trial-and-error procedure. The command is useful for producing audible prompts in a program, and by using short durations and variable tone values, you can achieve such noise effects as "raspberries," ricochets, and rocket blasts.

CALL should also have been a part of Level II or of disk BASIC. CALL does the same thing as a USR function but in a different way. USR(*x*) calls a machine-language routine whose entry location has been specified in a DEFUSR statement: CALL does this, but directly. CALL 22856, 56 puts the value 56 into the HL register pair and begins executing a machine-language routine at location 22856. Although this function is simple to use, it must have been difficult to incorporate into ENHBAS.

ENHBAS on Other Systems

I have used only the Model I disk and tape versions of ENHBAS. The tape version provides all of the enhancements mentioned above plus the disk-BASIC enhancements (except those used for disk control and the multiple USR calls, and CALL eliminates the need for the latter). The tape version is entered by using the SYSTEM command. Cornsoft has assured me that the only difference in the Model III version is that it did not at first support the printer-formatting options. By the time you read this, that problem should be corrected.

The Model II version of ENHBAS is superior to the Model I or III, largely because of the way the Model II handles interpreted BASIC. The Model II version includes some functions (like POKE and PEEK) that should have been included with the original system, as well as all the enhancements that are available for the Model I and III and a variety of others. The complete command set for the Model II version of ENHBAS is summarized in table 1 (taken from Cornsoft's advertising literature).

An Overview of ENHBAS

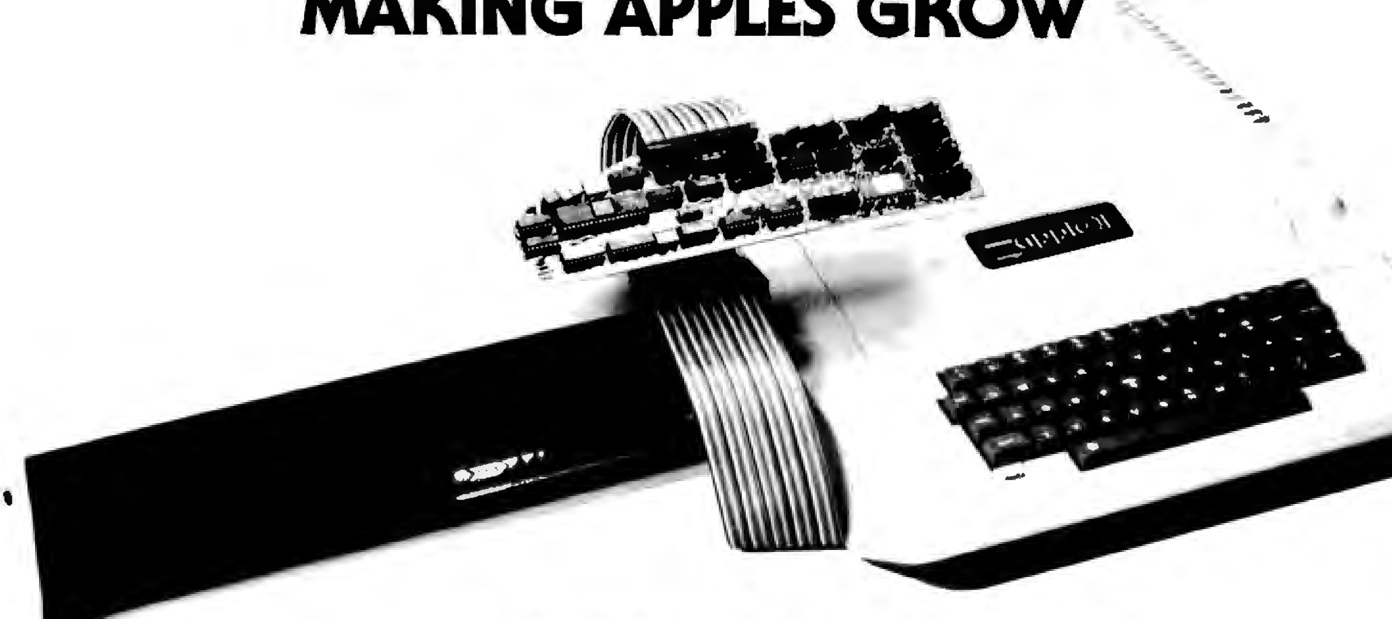
ENHBAS is outstanding software. Good software without support, however, isn't worth much. Support includes documentation, advice from the vendor, updates and modifications, and simple things like delivery and packaging. With ENHBAS, these are as outstanding as the software itself. For $5, and the return of your original ENHBAS disk, Cornsoft will provide updates.

Command	Meaning
DIR	Display disk directory
FIND	List line with specified label
TAG	Mark array to tag along at sort time
SCLEAR	Initialize SORT command
ATOP	Set top limit for SORT
JNAME	Identifies a label for use by GTO and CSUB
GTO	Special GOTO, allows labeled and calculated GOTOs
CSUB	Similar to GTO except accomplishes a GOSUB
RDGOTO	RESTOREs at specified line number
RDGTO	RESTOREs at specified label
WHILE/WEND	Structured loop construct (WHILE cond;: code: WEND)
INSERT	Moves entire file up by n records at specified point
OVERWRITE	Deletes n records in file starting at specified point
TSET	With INDEX FILE, specifies master file record as USED
TRESET	With INDEX FILE, specifies master file record as FREE
CURSOR	Allows changing of system cursor
EXEC	Executes a string expression as a program statement
ON BREAK GOTO	Branch to line number when the BREAK key is hit
BRL	Line at which BREAK was hit when branched to ON BREAK ...
OUTPUT	Acts as PRINT when exp = 0, LPRINT when exp = 1, can also send data to the RS232 ports
POP	Removes last GOSUB
PUSH	PUSHes a line or label address on the GOSUB stack
SCROLL	Sets number of lines to scroll-protect on the screen
TITLE	Automatically prints information at specified printer line
WPOKE	POKEs a 16-bit number at specified address
PI	Function, returns the value of pi
ENV	Function, returns the value of "e" (base of natural log)
BIN$	Function, returns 16-digit binary string of expression
LOWER$	Function, converts string to all lowercase
UPPER$	Function, converts string to all uppercase
SCREEN$	Reads a byte from the screen
DISKID$	Reads disk id from any disk drive
WINKEY$	Like INKEY$ except automatically loops until key hit
ALLOC	Function, returns number of files allocated
FREE	Finds first free entry in Index File (see TSET/TRESET)
CALL	Function, CALLs machine-language subroutine
EVAL	Evaluates a string expression as an algebraic expression
RS232	Function, reads a byte from RS232 Port A or B
SIZE	Returns size of current program
WPEEK	16-bit PEEK
POKE	Places number at specified memory address
PEEK	Function, returns contents of specified memory address
CLM, PAGE	Sets maximum page length and line length without FORMS
EPUT, EGET	Allows records lengths in excess of 256 bytes
SEARCH	Searches disk file (EGET/EPUT or GET/PUT type) for specified key
PAGELEN	Memory address of FORMS page-length variable
PROW	Memory address of FORMS page-length printer row

Table 1: *A summary of the command set of ENHBAS for the TRS-80 Model II.*

SVA

MAKING APPLES GROW



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Since Cornsoft Group is a new, small firm, I was apprehensive when I ordered ENHBAS. Experience with other vendors (some of them large and well-known) had led me to expect some bugs, poor delivery time, shoddy documentation, and so on. In this case, I expected to receive a padded manilla envelope with a crimped disk and some photocopied, jargon-laden documentation. Instead, within three days of placing a phone order, I received a box with a well-designed, blue 3-ring binder containing a disk and 55 pages of documentation. The documentation is superb. The page layout and format are pleasing and each feature is presented in logical sequence and described clearly and with good examples. (I find the documentation easier to use than either the Level II or disk BASIC manuals from Radio Shack and much superior to the documentation for NEWDOS, GSF, RSM2D, or even Microsoft's FORTRAN or BASIC compiler—and all those are excellent software.) The text is clearly written and, in contrast to most software documentation, not intimidating. It took me about three hours to feel comfortable with most of the features and the same should be true for anyone who knows the rudiments of BASIC and the TRS-80. I do wish ENHBAS could handle matrix manipulation and had automatic-key repeat, but you can't expect everything.

Are there any disadvantages? Some are to be expected with any product of this complexity, but all are minor, including the few mentioned above. Since ENHBAS includes new functions and statements, there are new reserved words, and that is sometimes inconvenient. For example, a program with the variable PI will not run with ENHBAS; you have to change the variable's name. And ENHBAS occupies a considerable amount of memory (I was thrown out of Scripsit a few minutes ago because ENHBAS was still loaded and protected). ENHBAS size in memory would be most important to those with 16 K- or 32 K-byte systems. The tape version occupies the same memory as do the disk overlays and leaves about 10.5 K bytes of usable memory in a 16 K-byte system. As mentioned above, with disk BASIC you have to relocate or not use any programs running in the top 4 K bytes of memory; they would overlap ENHBAS.

When I first used ENHBAS I expected it to run more slowly than disk BASIC. For the most part, I was pleasantly surprised. ENHBAS is slower by a factor of about 3 when executing a simple empty FOR-NEXT loop, but that seems to be about the only thing that is slower. If a function (like SIN(X)) is included in the loop, then the slower speed becomes insignificant. Programs with delay loops might need modifications, but everything else seems unaffected. I also thought that a labeled branch might be slower; if anything, it is faster than a branch to a line number. There is no need to fear that ENHBAS will be slow.

Conclusions

- ENHBAS is a software package that occupies about 4 K bytes of RAM and enhances the operating environment and the versions of BASIC for the TRS-80 Models I, II, and III. The operating environment provides a true control key, statement abbreviations, key click, a bell, audible prompts for BREAK and errors, printer formatting, and page skip, among other features. The BASIC enhancements include sort routines, branching to labels and other new branching methods, WHILE/WEND structure, line and vector graphics, CALL to a machine-language routine, and a number of other features, for a total of 32 new statements and functions.
- The BASIC enhancements follow normal syntax and are easy to learn and use. The system is easy to load, and except for the memory overhead, is transparent to the operator.
- User support is excellent. Documentation is clear, complete, sprinkled with useful examples, and packaged in an attractive 3-ring binder. The vendor provides excellent support and is willing to answer questions.
- The software is almost completely bug free. It was used for a year before commercial release and has been thoroughly tested and proved. ENHBAS seems to be one of the best thought-out and produced pieces of software available for the TRS-80.■

The Future with the Cornsoft Group

For the last four years a very few firms (like Microsoft) have dominated the design of operating systems, compilers, and interpreters. Others, like Randy Cook, Apparat, North Star, and Ohio Scientific have been exceptions, and a few individuals like Lance Micklus have produced some excellent software. The Cornsoft Group has the explicit, admitted intent of challenging the big companies, and ENHBAS proves that Cornsoft knows how to do it.

The excellence of ENHBAS has made me wonder about other Cornsoft products. I talked at some length with Philip Oliver, the author of ENHBAS, and learned that Cornsoft had also sold an ingenious compiler for integer BASIC. The compiler handled a subset of Level II plus some of ENHBAS and produced code that could be assembled by Radio Shack's Editor-Assembler. It was a good way to learn assembly language, and since source code was produced, you could enhance programs by using the TRS-80 editor—it's one of those simple ideas that we all wish we had thought of. Sadly, that product was discontinued due to lack of customer interest.

Oliver is now at work on a BASIC compiler that will handle all of Radio Shack BASIC plus the ENHBAS enhancements. This second compiler will produce machine code (not source code like their present compiler), and should rival Microsoft's compiler. Since Cornsoft's machine-code compiler will be written specifically for the TRS-80, it will use the more efficient ROM routines when appropriate, but its own routines when they are faster. The run-time package (and required disk storage) should be much smaller than for the Microsoft compiler.

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Ask BYTE

Conducted by Steve Ciarcia

Switching Interfaces

Dear Steve,

In the September 1980 *Popular Electronics,* there was an article regarding a digital delay line for audio purposes. Because the article employed the technique of digitizing the audio signal and passing it through memory to achieve the desired delay, I knew that it would probably be able to interface with a computer for further control. To achieve the desired delay, BCD thumbwheel switches were used to select the memory addresses. (These switches connect to two 74193 chips. I suspect they are used to decode the addresses.)

I would like my computer to be able to turn these switches on and off as programmed. What type of interface would be needed to connect this delay line (switch connection points) and my computer?

I have an S-100 machine (Processor Technology Sol-20 with 48 K bytes of memory) with both a serial and a parallel port. Can this connection be made with relays, opto-coupling, electronic gates, etc?

Rick Downs
Aurora CO

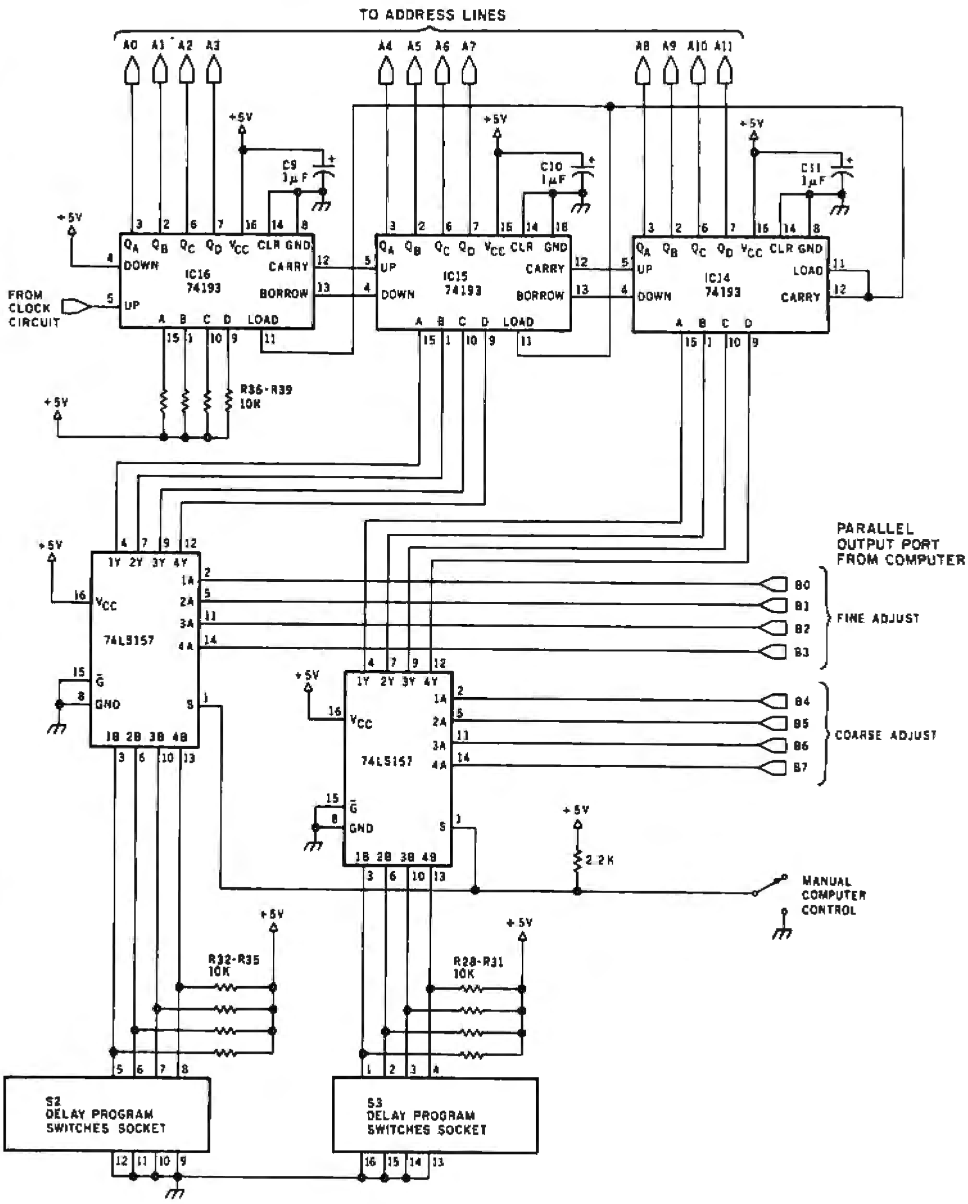


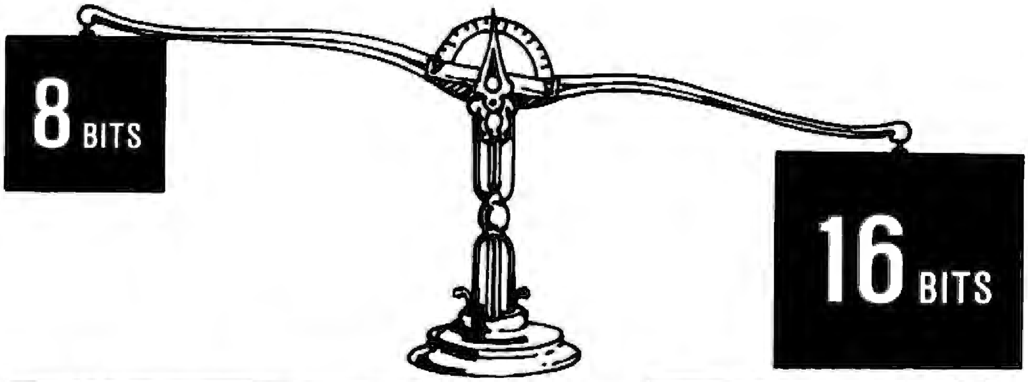
Figure 1: *The audio delay circuit that originally appeared in* Popular Electronics *modified for control by an 8-bit parallel port.*

I don't usually like to take up room in BYTE with specific changes to schematics printed in other magazines, but this schematic is valuable in demonstrating how to attach a computer to any circuit that normally uses mechanical switches, such as the thumbwheels shown in the diagram.

The circuit originally published was an audio delay circuit that employed an 8-bit companding A/D (analog-to-digital) converter (an 8-bit converter which emulates the dynamic range of a converter with 11 bits plus sign). While I have not built this particular digital delay system, I'm familiar with the circuitry. I suspect that it might add some interesting effects to high fidelity.

The normal method of achieving the delay is to use three 74193 presettable binary counters. By presetting the addresses, it's possible to predesignate the total steps in the timing chain and, therefore, the length of the delay.

Figure 1 is a redrawn circuit demonstrating modifications that will allow you to attach it to your Sol-20 (or any other computer with a parallel port). By adding two 74LS157 multiplexers, you can either preset the 74193s from your 8-bit parallel output port or use the thumbwheel switches. When the Manual/Computer selection switch is in the open position, the thumbwheel switches will



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have control. When it is closed, the delay parameters will come from the computer.

It's possible to use a similar computer-control technique in place of switches on virtually any electronic appliance. You must ensure that the electronic instrument being controlled has an isolated power supply. According to the original article, this delay line does. . . . **Steve**

Wrapping Noise

Dear Steve,

Would it be possible to wire-wrap the Disk-80 project you presented in the March 1981 BYTE (see "Build the Disk-80: Memory Expansion and Floppy-Disk Control," page 36), or would it be too susceptible to noise?

Richard Mozeleski
Thorndike ME

While it is quite possible that wire-wrapping would be neater than hand-wiring, the TRS-80 Model I is extremely susceptible to noise induced through its external bus connector. That's why I hesitate to suggest wire-wrapping or hand-wiring it.

If you really want to try it, by all means go ahead. However, there is a printed-circuit board available for the Disk-80 from the Micromint Inc, 917 Midway, Woodmere NY 11598, (516) 374-6793, that should do the trick. You will probably find that the cost of wire-wrapping sockets alone will far exceed the price of the printed-circuit board ($48). . . . **Steve**

A Catch-25

Dear Steve,

I recently purchased a Radio Shack TRS-80 Model III, and I'm interested in interfacing it to some of your projects. The problem is that the Model III's expansion connection has been changed from the Model I's 40 pins to 50. Upon examining the connector closely, I see that one side has all its pins (25) connected to ground. This, it seems, leaves only 25 pins to do the job of the 40.

Do you have any information about the arrangement of this connector? Radio Shack's manual simply says "for future expansion" and gives no other details. The store personnel know nothing about it, except that a technical manual is due.

John Uffenbeck
Salinas CA

There is quite a difference between the Model I and Model III's expansion connectors. Since the Model I's disk controller must be outside of the keyboard unit, all the processor's signals are available for use on the Expansion Interface. This means that the full 16-bit address bus, the bidirectional data bus, and all the control lines are available.

On the Model III, the disk controller and 48 K bytes of expansion memory are mounted inside the enclosure; it is unnecessary to bring out all of the address and control lines. Therefore, the Model III's expansion connector is simply for I/O *(input/output) rather than complete system expansion. Only eight address lines and eight data lines are brought out (plus some handshaking signals), and the I/O functions must be enabled under program control (the command is OUT 236,16).*

On the whole, both computers work equally well with peripherals that only require output data. But reading input data with the Model III is much more involved. The data-bus direction is controlled by the external peripheral. To make the computer input data, a peripheral must recognize its own address, activate the I/O Input Strobe, and logically switch the data bus to receive input information. Unlike the Model I, which could allow a single I/O device to be used with absolutely no address decoding (presumably any I/O-related instructions had to be for that peripheral because nothing else used I/O instructions), address decoding is an absolute requirement on the Model III. . . .
Steve

Pitch for Voice Recognition

Dear Steve,

I am 13 years old, and I own a TRS-80 Model I Level II. I'm interested in pitch analysis and voice recognition. I already have my computer knowing when a sound is present: I set my cassette recorder to record and run the program shown in listing 1.

I would like to know how to build a device that would change a tone or pitch to a numerical value that could then be read by my computer. I cannot figure out how to get my computer to recognize the difference between two pitches. Can you help me?

Eric Korenman
New York NY

To be able to do anything of real value in speech recognition or even to detect more than one tone, you will have to learn how to write your programs in machine-language, because they run much faster than BASIC.

The usual approach to voice recognition is to use a bank of bandpass filters *and* zero-crossing detectors. *You would have three or four frequency bands of interest, and you would use the computer to analyze how many times the voice is present in these bands. To do that, you would count the number of times this signal crosses zero.*

In the simplest designs, the output of the filters is normalized to a logic 1 or logic 0. Every time a signal is present, the filter output becomes a logic 1. When there's no signal, the output is logic 0. A

Listing 1

```
10 I = INP(255)
20 IF I = 255 THEN PRINT "SOUND PRESENT" ELSE 10
30 OUT 255,0: GOTO 10
```

machine-language program simply counts how many times this signal is present.

The human voice contains more than single tones, of course, and there will be frequent zero crossings. Therefore, any program you use must be able to count at a high rate as well as look at all the filters. Such speed can only be accomplished with a machine-language program.

There have been various articles on speech recognition in a number of magazines, and I'm sure you will be seeing more in the future. I have a few designs on the drawing board for a speech-recognition circuit. I will unveil one in a "Circuit Cellar" article as soon as it works well enough.

Keep up your interest, and perhaps we'll both be talking to our computers soon. . . . **Steve**

What's In a ROM?

Dear Steve,

I would like to do some game programming for an Atari video game, but I don't know what type of ROM (read-only memory) is used. Can you help me, or do you know where I can get the schematics for an Atari game?

Frank Weatherford
Gray TN

Atari games generally consist of either 4 K- or 8 K-byte ROM packs. One of the prerelease ROM packs that I received had 2732 EPROMs (erasable programmable read-only memories) in it. This would imply that you could substitute 2716 or 2732 EPROMs in most cases. I have known some people who have taken ROMs out of inexpensive game packs and replaced them with their own software. . . . **Steve**

Home-Control Design

Dear Steve,

I would like to ask you for some help. A friend of mine is a quadriplegic who has great difficulty when he is home alone. Because he is unable to type, a voice-operated system is most desirable. If you could design a system, he could get someone to install it.

Jonathan Shaw
Tampa FL

You'll forgive me, of course, for not wishing to design a system specifically for you. That is a tremendous undertaking which could take months, even years, of work. Instead, I recommend that you contact Artra Inc. This company makes an interface card called Housemaster. I have tried it, and it works reasonably well.

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Toward a Structured 6809 Assembly Language

Part 1: An Introduction to Structured Assembly Language

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Structured programming is the rage these days, as reflected in the growing popularity of structured high-level languages like Pascal and C. Yet most of the programs written today use languages that are not well-structured, such as FORTRAN, BASIC, and assembly language.

Assembly language, widely used in industry, is becoming more and more available on personal computers. And although assembly language is the first and last bastion of convoluted programming, there is a way to add structured programming statements to an existing assembly language. In fact, structured control statements can be added to any existing language.

Part 1 will examine the meaning of structured programming and present a set of structured control statements for the MC6809 assembly language, as well as programming examples that use these structured statements. Part 2 will show how to add structured statements to the MC6809 macroassembler or to any programming language.

Acknowledgments

I would like to express my deep appreciation to Joel Boney, who originally suggested the form and implementation strategy for the 6809 structured macros, and to Greg Stevens, who helped debug the macros.

Structured Control Statements

It has become popular, perhaps even faddish, to extol the virtues of structured programming. Yet its exact meaning remains rather ambiguous. Thus, the latest high-level language is sold much like the latest brand of shampoo: "It will leave your programs cleaner and more manageable."

When a language is said to be "structured," the usual meaning is that the language contains statements for the structured flow of control. Edsger Dijkstra is generally credited with originating structured programming with his letter in *Communications of the ACM* (see references) which stated that the GOTO statement seemed to be a major source of programming errors. Since that time, the terms *GOTOless programming* and *structured programming* have sometimes been used interchangeably. Yet the GOTO, in the form of *jump* or *branch* instructions, is still firmly fixed in machine instruction sets of new computers. Let's see what is so bad about the GOTO and, at the same time, try to discover why it remains long-lived in spite of its reputation for abetting errors.

Computers are general-purpose machines because of their ability to perform a different sequence of calculations based on tests of the input data. The most primitive computer instruction that allows this ability is a *conditional branch* instruction, which transfers control to a different part of the computer program based on a run-time test. An example of this instruction is shown in listing 1. (See also figure 1.) This program changes the contents of A into its absolute value by using three simple steps:

- The contents of A are compared to zero;
- If the result shows A greater than or equal to zero, then a branch is taken around the next statement;
- Else the value of A is negated to make it positive.

The ability to perform a conditional branch allows more than selection between two different paths of program execution; by branching back to the beginning of a section of program, it is possible to create a *loop* (ie: a calculation that can be repeated many times). Listing 2

Listing 1: *Assembly-language statements for determining absolute values.*

```
        CMPA    #0
        BGE     POS     If register A is less than zero
        NEGA                negate it,
POS     EQU     *       Else continue
```

Listing 2: *Assembly-language statements for adding the value 5 to each element of an array.*

```
*
ARRAY   RMB     10              DECLARE ARRAY
*
START   LDB     #0              INITIALIZE INDEX TO ZERO
        LEAX    ARRAY,PCR       POINT TO START OF ARRAY
LOOP    LDD     B,X
        ADDD    #5              ADD 5 TO ONE ARRAY
        STD     B,X                ELEMENT
        INCB                    UNTIL INDEX IS >= 10
        CMPB    #10
        BLT     LOOP
```

shows an example of a loop that adds the value 5 to every number stored in an array.

By the proper combination of loops and conditional branches, all the complexity of modern computer programming is possible—even the creation of programs that play a sophisticated game of chess or balance the bank accounts of thousands of customers.

Problems arise when this primitive form of branch instruction is used directly to write programs. In both examples the branch instructions contain a condition that is tested for and a labeled location in the program where execution is to resume if the condition is true. The biggest problem is the need for that label.

A well-chosen label can make the branch instruction somewhat self-explanatory. In listing 1, the word POS indicates that the branch occurs in the case of a positive number. In listing 2, there is indication that the branch forms part of a loop. However, programs of even moderate complexity will have numerous conditional-path selections and several loops, often nested one inside the other. For every branch, the programmer must think up a label that somehow describes the operation of the program and yet is different from all other labels. Usually, the important operation to explain is the branch itself, so that a label that has meaning for the branch instruction means nothing at the remote location in the program where the label is actually defined.

The difficulty in thinking up really meaningful labels quickly overwhelms the programmer, who would rather concentrate on getting his program to work. Thus, many assembly-language programs are filled with labels such as LOOP, LOOP2, LOOP3, etc. While this labeling might be useful for counting the number of loops in a program, it does not go far toward explaining how the program operates. Use of meaningless labels is not due to laziness on the part of programmers; rather, it stems from a limitation inherent in assembly language—namely the limitation of requiring labels at points of the program that are not important to the operation of the program.

Although assembly language was used in these examples, the complaints are equally applicable to any language whose control mechanisms are those of a GOTO label. FORTRAN and BASIC programmers take note.

The real problem with the GOTO construct is that it is *too general* a programming form. It is incorporated into machine instruction sets for exactly that reason: it can efficiently implement many different higher-level constructs. From the point of view of the programmer, though, such generality hides the specific construct he had in mind.

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ming languages were designed and tested, the use of various higher-level (ie: more abstract control structures) was explored. As a result, there is now a widely accepted set of such structures available in "structured" programming languages. Three of the most popular structures will be discussed individually by exploring their use in 6809 assembly language.

MC6809 Language Structures

In the system presented here, there are three different structuring forms available—one for conditional execution and two for creating loops. They are:

IF...ELSE...ENDIF
WHILE...ENDWH
REPEAT...UNTIL

IF

Together, the IF, ELSE, and ENDIF macros allow selection between two different paths of execution through the program, depending on the result of a conditional test. The form of the IF structure is:

IF <register >,<relational operator>,<address expression>
(block of statements to be executed if conditional is true)
ELSE
(block of statements to be executed if condition is false)
ENDIF

Notice that the three structured statements serve to bracket two blocks of assembly-language statements. Should the condition prove true, the block between the IF and ELSE statements is executed; otherwise, the block of statements between the ELSE and ENDIF statements will be executed.

Programmers who use an existing structured language may find the terminating ENDIF somewhat unusual. Pascal, for example, uses a *begin...end* pair to bracket a block of executed statements in all of its control structures. It happens that having a different terminating statement for each control structure makes these statements easier to implement and easier to read. Once you are familiar with this style, the extent of a particular statement is visible at a glance, unlike Pascal, where it is a tedious and error-prone process to match up each *end* with its corresponding *begin*.

Listing 3 shows an example of an IF structure and the equivalent assembly-language statements. The IF statement forms a conditional test by a signed comparison (CMP instruction) between the contents of an MC6809 register (either 8-bit or 16-bit) and the contents of an effective address. All user-programmable

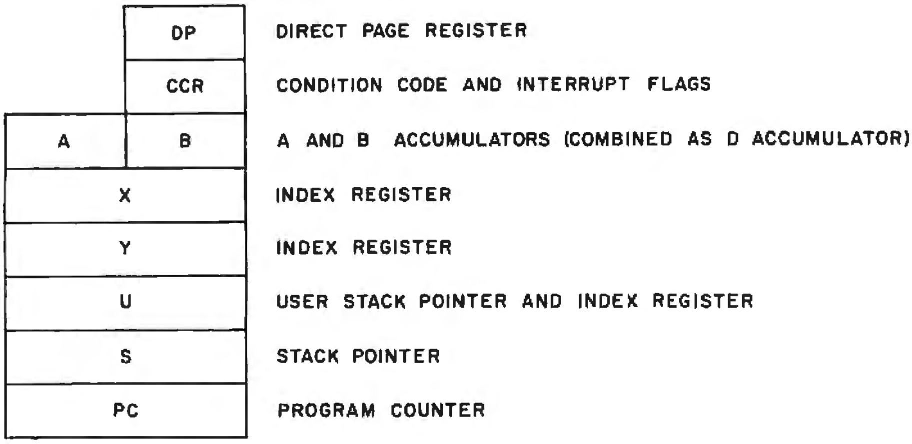

Figure 1: *Register model of the Motorola MC6809 microprocessor. In addition to its program counter (PC) and stack pointer (S), the MC6809 has four user-programmable 16-bit registers: X, Y, U, and D. (D is equivalent to a concatenation of registers A and B.)*

Listing 3: *Example of the IF construct in standard assembly language and structured assembly language. This code checks the validity of an argument in the D register for use by a square root routine.*

```
Allowed registers: A, B, D, X, Y, U, S.

Allowed relational operators:

      EQ -- equal to
      NE -- not equal to
      GE -- greater than or equal to
      GT -- greater than
      LE -- less than or equal to
      LT -- less than
```

Structured Code

```
  IF D,GE,#0

    JSR SQROOT
  ELSE

    JSR ARGERR
  ENDIF
```

Equivalent Code

```
         CMPD #0
         BLT  LABEL1
            JSR  SQROOT
         BRA  LABEL2
LABEL1   EQU  *
            JSR  ARGERR
LABEL2   EQU  *
```

Listing 4: *Example of the IFTST construct. The routine takes the absolute value of the memory byte at CAT offset from the X register.*

```
Allowed registers: A,B,D,X,Y,U,S, or address expression

Allowed relational operators: EQ, NE, GE, or LT.
```

Structured Code

```
   IFTST (CAT,X),NE

      NEG   CAT,X
   ENDIF
```

Equivalent Code

```
          TST   CAT,X
          BEQ   LABEL1
           NEG CAT,X
LABEL1    EQU    *
```

registers, including the stack pointer, are allowed. Any signed relational operator is allowed, and the relational operator names will be familiar to all FORTRAN programmers.

The address expression may contain any of the MC6809 addressing modes. The ELSE and ENDIF statements serve as destinations for branches around the blocks of assembly-language statements. Notice that two labels are avoided for each IF structure, making the structured code much simpler to write and read than its equivalent assembly-language form. The ELSE macro and the block of code following it are optional.

Two other forms of the IF statement were created to take advantage of specific MC6809 instructions. Two different instructions are available on the MC6809 to perform a test on a value: CMP (compare) and TST (test against zero). These are reflected in the IF and IFTST control macros. The IFTST macro generates a TST instruction instead of a CMP instruction, and so gives a signed comparison of a register (or a byte in memory) with zero. Listing 4 shows an example of the IFTST statement.

The ELSE and ENDIF macros are used with the IFTST in the same manner as with the IF macro. Optionally the programmer may add a third argument of #0 to improve readability, as in:

```
IFTST     D,NE,#0
```

This third argument is ignored by the IFTST statement.

A third form of the IF statement is

Listing 5: *Example of the IFCC construct.*

```
Allowed relational operators: EQ, NE, GT, GE, LT, LE, and

        CS -- carry flag is set
        CC -- carry flag is clear
        VS -- overflow flag is set
        VC -- overflow flag is clear

        Structured Code           Equivalent Code

        ROLA                            ROLA
        IFCC  GT                        BLE   LABEL1
           JSR  DOIT                     JSR  DOIT
        ENDIF                     LABEL1 EQU   *
```

Listing 6: *Example of the WHILE construct.*

```
Allowed registers: same as IF.

Allowed relational operators: same as IF.

       Structured Code          Equivalent Code

        WHILE A, GT, #0     LABEL1 CMPA    #0
                                   BLE     LABEL2
          LSL B                      LSLB
          DEC A                      DECA
        ENDWH                      BRA     LABEL1
                            LABEL2 EQU     *
```

Listing 7: *Example of REPEAT loop construct. The routine will shift register B based on the value in register A.*

```
Allowed registers: same as IF.

Allowed relational operators: same as IF.

      Structured Code           Equivalent Code

        REPEAT                  LABEL1  EQU  *
          LSL B                      LSLB
          DEC A                      DECA
                                   CMPA        #0
        UNTIL A, LE, #0            BGT         LABEL1
```

Listing 8: *Programming example written without the benefit of structured statements.*

```
*
*       CONVERT BINARY TO DECIMAL AND STORE 5 CHARACTERS
*          (AFTER EXAMPLE ON PAGE 10-10 OF MC6800 MICROPRO-
*           CESSOR PROGRAMMING MANUAL)
*
*       ON ENTRY:
*                (D) = 16-BIT UNSIGNED BINARY VALUE.
*                (X) = POINTER TO LOCATIONS RECEIVING CHARACTERS.
*       REGISTERS USED:
*                (Y) = POINTER TO CONSTANTS FOR THE CONVERSION.
*       ON EXIT: D AND X ARE BASHED, OTHER REGISTERS UNCHANGED.
*
*       THIS SUBROUTINE IS RE-ENTRANT AND POSITION-INDEPENDENT.
*
*       TEMPORARY STORAGE ON THE STACK IS: SAVLOB AND DIGCNT.
*
SAVLOB  EQU     0               TEMP. STORE LOW ORDER BYTE
DIGCNT  EQU     1               STORES COUNT TO CREATE DECIMAL DIGIT
*
CVBTD   PSHS    Y
        LEAS    -2,S            RESERVE LOCAL STORAGE
        LEAY    K10K,PCR
CVDEC1  CLR     DIGCNT,S
CVDEC2  SUBD    ,Y
        BCS     CVDEC5          BRANCH ON OVERFLOW
        INC     DIGCNT,S        INC CHAR BEING BUILT
        BRA     CVDEC2
*
CVDEC5  ADDD    ,Y++            RESTORE PARTIAL RESULT
        STA     SAVLOB,S        SAVE LOW ORDER BYTE
        LDA     DIGCNT,S
        ADDA    #$30            CHANGE DIGIT TO ASCII CHAR
        STA     ,X+                AND SAVE IN RESULT
        LDA     SAVLOB,S        RESTORE LOW ORDER BYTE
        CMPD    #0
        BNE     CVDEC1
*
*               CLEAN UP STACK AND RESTORE REGISTERS
        LEAS    2,S
        PULS    Y,PC
*
*               STORAGE FOR CONVERSION CONSTANTS
K10K    FDB     10000
        FDB     1000
        FDB     100
        FDB     10
        FDB     1
        END
```

the IFCC, which selects an execution path based on the existing condition code flags. Its only operand is a relational operator. An example of the IFCC appears in listing 5. At first glance this form of the IF may seem unnecessary, since it only generates a single branch instruction. It is useful, however, because it eliminates the need for the programmer to create a label.

WHILE

The WHILE...ENDWH statements bracket a block of assembly code to form a conditional-loop control structure. The WHILE specifies a signed comparison (CMP) of the same form used by the IF statement. The instructions between the WHILE and the ENDWH are executed as long as the condition is true. The condition is tested at the beginning of each traversal of the loop. An example of the WHILE statement appears in listing 6. The code performs a multiple left shift of B based on a count in A.

REPEAT

The REPEAT...UNTIL macros provide a conditional-looping construct in which the condition is tested *after* each traversal of the loop. Thus, the code in a REPEAT loop will always be executed at least once. The UNTIL macro specifies a signed comparison

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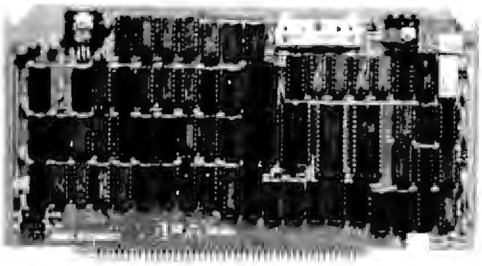

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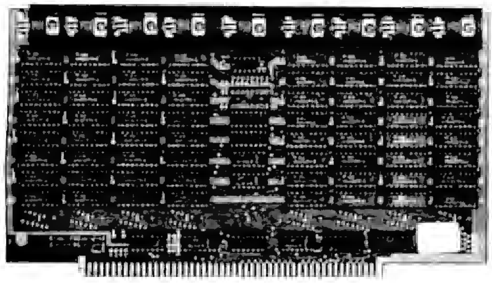

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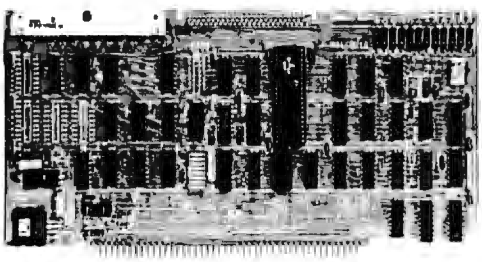

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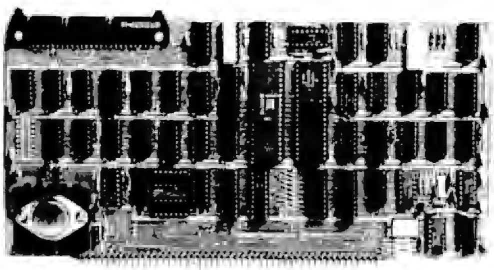

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Listing 9: *The programming example of listing 8, written in structured assembly language.*

```
*
*        CONVERT BINARY TO DECIMAL AND STORE 5 CHARACTERS
*
*                    (WRITTEN WITH STRUCTURED MACROS)
*
SAVLOB   EQU      0                    TEMP  STORE LOW ORDER BYTE
DIGCNT   EQU      1                    STORES COUNT TO CREATE DECIMAL DIGIT
*
CVBTD    PSHS     Y
         LEAS     -2,S
         LEAY     K10K,PCR
         REPEAT
           CLR    DIGCNT,S
CVDEC2     SUBD   ,Y
           IFCC   CC                   UNLESS THERE WAS OVERFLOW
             INC  DIGCNT,S               INCREASE DECIMAL DIGIT
             BRA  CVDEC2                 LOOP TO TEST AGAIN
           ENDIF
*
           ADDD   ,Y++                 RESTORE PARTIAL RESULT
           STA    SAVLOB,S             STORE LOW ORDER BYTE
           LDA    DIGCNT,S
           ADDA   #$30                 CHANGE DIGIT TO ASCII CHAR
           STA    ,X+                     AND SAVE IN RESULT
           LDA    SAVLOB,S             RESTORE LOW ORDER BYTE
         UNTIL    D,EQ,#0
*
*                 CLEAN UP STACK AND RESTORE REGISTERS
         LEAS     2,S
         PULS     Y,PC
*
*                 STORAGE FOR CONVERSION CONSTANTS
K10K     FDB      10000
         FDB      1000
         FDB      100
         FDB      10
         FDB      1
         END
```

(CMP instruction) of the same form as that used by the IF macro. Listing 7 presents an example of a REPEAT loop. The code will left shift B based on a count in A.

Nesting of Structures

The structured statements may be used anywhere in an assembly-language program. The block of statements bracketed inside one control structure may itself contain other structured statements. This is known as the *nesting* of control structures. The only restriction to observe is that each control structure must be wholly contained within a single block of assembly statements; the statements of two control structures may not overlap. The number of control structures contained one within the other is called the *depth of nesting*.

Long Branch Option

The structured assembly statements all generate short relative branch instructions, which may reference locations a maximum of 127 bytes away from the location of the

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branch instruction. If this range is exceeded, a long branch is required; an error message will be printed telling which branch needs to be flagged as being "long." By appending the character "L" as an additional item in the conditional expression, the programmer may force the generation of a long relative branch.

Statements which cannot receive an L parameter will print an error message if an L is appended. The following statements may be flagged as "long":

- IF: branches over code between IF and ELSE or ENDIF
- ELSE: branches over code between ELSE and ENDIF
- WHILE: branches over code between WHILE and ENDWH
- UNTIL: branches over code between REPEAT and UNTIL

For example, the L flag may be used with the IF structure as follows:

```
IF U, NE, #BOTTOM,L
   (long-code segment)
ELSE
   (short code segment)
ENDIF
```

or:

```
IF S, GT, #STAKND
   (short code segment)
ELSE L
   (long code segment)
ENDIF
```

In order to really demonstrate the difference these structures make in reading a program, "before" and "after" examples are shown in listings 8 and 9, respectively. A program originally appearing in the *MC6800 Programming Manual* has been recoded for the 6809, using control structures. This example is a compelling argument for using structured macros for two reasons:

- It is not contrived: the original program is typical of assembly-language subroutines written by a "good" programmer.
- The translation of structures into assembly code will produce *exactly the same instructions* as those in the original program.

The second reason cannot be overemphasized: the use of control structures does not produce inefficient programs. The inefficiency associated with the use of high-level languages arises from other sources.

The presence of the unstructured branch to CVDEC2 in listing 9 might at first seem to show that structured statements are inadequate for assembly-language programming. On the contrary, the branch could have been replaced by structured statements at the expense of generating a longer assembly-language program. In fact, the branch shows that the optimizing tricks sometimes required in assembly language can still be used with the structured statements. After extended use, it becomes obvious that the structured control statements are exactly what is needed in the vast majority of programming situations.

Part 2 of this article will discuss *macros*, the programming tools from which the structured statements are constructed. It will present the specific macros needed to create structured statements for the MC6809 and will explain how these macros operate. ■

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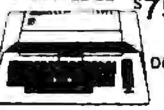

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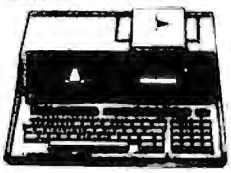

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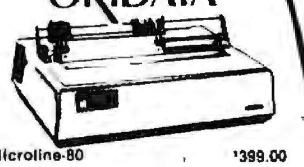

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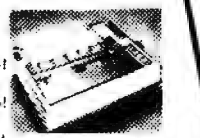

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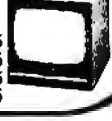

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PROLOG

A Step Toward the Ultimate Computer Language

Ron Ferguson
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What will the ultimate computer language be? What language will we be using once assembler language, BASIC, and Pascal have become museum pieces? Surprisingly, this question is easy to answer: there will be several ultimate computer languages. We even know what their names will be. They will be called English, Spanish, French, Russian, Chinese, etc. After all, the easiest language you could use to program a computer is the one you use to communicate with other people.

Unfortunately, programming a computer in English is still in the future. For a computer to understand English, it must be able to cope with the ambiguities inherent in any natural language. It must be able to deduce facts you don't bother specifying because they are "obvious." (Nothing is obvious to a computer unless it has been programmed to realize it is obvious. Everything must be stated explicitly and precisely.)

Today, though, we do have a language, called PROLOG, that simplifies the task of informing a computer about obvious (and not so obvious) facts. The name PROLOG is short for "PROgramming in LOGic"; however, you do not have to be familiar with formal logic theory to use PROLOG. In fact, the language is so simple a child can learn it. Yet its very simplicity makes it far more powerful than any other language currently available for use on microcomputers.

PROLOG is a programming language ideally suited to the manipulation of knowledge. A PROLOG program consists of facts about a certain subject. You can ask PROLOG questions and it will attempt to answer them using the facts it has been told.

Facts are expressed in PROLOG in a concise manner. The fact that John is the father of Tom is expressed by the one-line PROLOG program:

```
father(john,tom).
```

The relationship, father, appears first, followed by the arguments (in parentheses) to which the relation applies. This data structure is called a *term*. The only potential area of confusion is the order in which the arguments are written. As a rule, the subject of the relation is the first argument and the object is the second. With this program, you can now ask PROLOG whether John is the father of Tom:

```
father(john,tom)?
```

to which PROLOG will respond:

```
yes
```

Note that the only difference between *telling* PROLOG that John is Tom's father and *asking* PROLOG whether John is Tom's father is the punctuation mark at the end of the statement. An assertion always ends with a period; a question always ends with a question mark. If you ask whether John is the father of Bill:

```
father(john,bill)?
```

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PROLOG will respond:

no

because it does not have any information to indicate that John is the father of Bill.

You can ask PROLOG more complicated questions such as who the father of Tom is by typing:

```
father(%who,tom)?
```

The % at the beginning of "%who" indicates that "%who" is a variable. When a question contains a variable, PROLOG attempts to assign a correct value to the variable. PROLOG will respond to the above question with:

```
%who = john
```

If PROLOG cannot find a correct value for the variable, it again responds no.

```
father(%who,bill)?
no
```

As is the case in most programming languages, it does not matter what name you use for a variable. You can have used "%x" instead of "%who". However, unlike most programming languages, a PROLOG variable's scope is limited to the statement in which it appears. If the same variable name is used in two separate statements, there is no connection between them. They are treated as different variables.

So far, PROLOG appears to be nothing more than an easy-to-use data-base language. You can store information and retrieve it later by asking questions. What makes PROLOG more than just another data-base language is that you can teach PROLOG how to manipulate the facts you have given it. Assume that you have made the following assertions:

```
father(bill,john).
father(john,tom).
```

From these assertions, you can deduce that Bill is the grandfather of Tom. PROLOG can also make this deduction if you tell it the fact that the father of the father is the grandfather. In PROLOG this fact is stated as a clause:

```
grandfather(%x,%z) ← father(%x,%y),father(%y,%z).
```

← means "is implied by" or "is true if." The term to the left of ← is true if the terms to the right of ← are true. The term to the left is called a *goal*, and the terms to the right are called *subgoals*. The goal is true if the subgoals are true. The goal is also referred to as the *head term* of the statement.

Note that variables have been used in the clause to make a general statement about what it means for some-

one to be the grandfather of someone else. PROLOG can use this general statement to answer specific questions. If you ask the question:

```
grandfather(bill,tom)?
```

PROLOG will attempt to answer by setting "%x = bill" and "%z = tom" in the definition of grandfather. This creates an instance of the grandfather definition of the following form:

```
grandfather(bill,john) ←
father(bill,%y),father(%y,tom).
```

This states that Bill is the grandfather of Tom if Bill is the father of a person who is the father of Tom. By the first two assertions, PROLOG knows that Bill is the father of John and John is the father of Tom. Therefore, PROLOG will respond with a yes.

If you ask PROLOG to find two people such that one is the grandfather of the other:

```
grandfather(%x,%y)?
```

PROLOG will respond:

```
%x = bill, %y = tom
```

Nonprocedural Languages

Most computer languages currently in use (such as BASIC and Pascal) are procedural: a computation is performed by executing a series of actions in a precise order. Each statement of a procedural language represents only one step in an algorithm. This means that the correctness of an individual statement cannot be determined by examining the statement by itself. Instead, you must examine the entire algorithm in which the statement occurs to determine if the statement is correct. For example, I = I + 2 is a typical statement in a procedural language. If you are asked to determine whether the statement is correct, the most you can say is that its syntax is correct (ie: it is a valid statement in the language). This does not necessarily mean that the statement is the correct one to use at that particular stage of the algorithm. Perhaps the correct statement should be I = I * 2. You cannot tell without looking at the rest of the code in which the statement appears.

In PROLOG, on the other hand, you can determine whether a statement is true by examining that statement only. The correctness of the PROLOG statement that defines grandfather can be determined independently of the rest of the PROLOG program. A statement in a PROLOG program corresponds to an entire subroutine in a conventional programming language. Thus PROLOG programs are extremely modular. PROLOG carries the "divide-and-conquer" approach of structured programming one step further.

Another advantage of nonprocedural languages is that the order in which statements occur is irrelevant. Each PROLOG statement represents a fact, and it does not matter in what order PROLOG is told the facts. This means that you can increase the power of a program by adding new statements, and in most cases this does not require any modification of the statements that are already there. For example, the definition of grandfather, given earlier, is true, but it is only a partial definition. One must add the following statement to obtain a complete definition:

```
grandfather(%x,%y) ←
father(%x,%z),mother(%z,%y).
```

Assume that the following assertions are also made:

```
mother(jane,alice).
father(bill,jane).
```

Now if you ask for a grandchild of Bill:

```
grandfather(bill,%grandchild)?
```

PROLOG will respond:

```
%grandchild = tom
```

You can also find out if Bill has another grandchild by

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typing ?. Now PROLOG will respond:

%grandchild = alice

If you ask whether Bill has other grandchildren besides Tom and Alice by typing ? once more, PROLOG will respond with a no.

The two partial definitions for grandfather can be combined into one statement:

grandfather(%x,%y) ← father(%x,%z),
(father(%z,%y);mother(%z,%y)).

The semicolon between "father(%z,%y)" and "mother (%z,%y)" means that one or the other must be true.

A term can have any number of arguments. To say that Alice is pretty, you would type:

pretty(alice).

Now you can ask PROLOG to find a pretty grandchild of Bill, as follows:

grandfather(bill,%grandchild),pretty(%grandchild)?

to which PROLOG will respond:

%grandchild = alice

How PROLOG Works

To use PROLOG you do not need to know how it actually arrives at its answers. If you have specified all the required information, PROLOG will find the answer as if by magic. However, it is interesting to know how it goes about coming up with a solution.

Basically PROLOG attempts to solve goals from left to right. For a given goal, PROLOG attempts to find a statement whose first term (the only term in an assertion; the term to the left of the ← in a clause) can be made to match the goal. It then attempts to solve the subgoals of that statement. Of course, if the statement is an assertion, there are no subgoals. If the subgoals can be solved, PROLOG then proceeds to the next goal. If one of the subgoals cannot be solved, PROLOG backtracks and tries to find another statement whose head term matches the goal. If there are no untried statements left, PROLOG realizes it cannot solve this particular goal.

This does not necessarily mean there is no solution to your original question. If the goal PROLOG is working on is actually a subgoal of one of your original goals, there may be an alternate solution of the original goal that does not involve the failed subgoal. PROLOG will backtrack further and try to find an alternate solution; it gives up only when it can find no solution to any of your original goals.

Let us examine in more detail how PROLOG works.

Listing 1: *Assertions that specify the environment. PROLOG attempts to answer questions based on facts and relations that it knows, stated in special syntax. Questions are broken into goals to be achieved from left to right.*

```
father(bill,john).
father(john,tom).
father(bill,jane).
mother(jane,alice).
grandmother(%x,%y)<- father(%x,%y),(father(%z,%y);mother(%z,%y)).
pretty(alice).
```

Assume that the statements in listing 1 have been made. Now assume that PROLOG is asked this question:

grandfather (bill, %grandchild), pretty(%grandchild)?

Because PROLOG attempts to answer questions by solving goals one at a time from left to right, it will first attempt to solve "grandfather(bill, %grandchild)". It searches for a clause whose first term is grandfather. There is only one clause whose head term is grandfather, so PROLOG tries to match "grandfather (bill, %grandchild)" with "grandfather(%x, %y)". A match can be made by setting "%x = bill" and "%y = %grandchild". This substitution is applied to the subgoals of that statement, which may be expanded to:

father(bill, %z),(father(%z, %grandchild);
mother(%z, %grandchild))

PROLOG now attempts to solve "father(bill, %z)". The first three statements have father as a head term, so PROLOG tries them one after the other. The first statement matches if "%z = john"; it is an assertion and has no subgoals. Therefore, PROLOG can proceed to the next goal in the expanded statement. Here there is a choice between "father(john, %grandchild)" and "mother(john, %grandchild)". PROLOG attempts to solve the first alternative. It tries to match "father(john, %grandchild)" with the first given statement, but fails because the first arguments do not match. It then tries the second statement, and this time succeeds with the substitution "%grandchild = tom".

Now all the goals of the expanded statement have been satisfied, so PROLOG attempts to solve the last goal of the original question. Since "%grandchild = tom", the goal is "pretty(tom)". There is only one clause whose head term is "pretty", but "pretty(tom)" does not match "pretty (alice)". At this point, PROLOG backtracks to the last place where there was a choice—between "father(john, %grandchild)" and "mother(john, %grandchild)"— and selects the alternate choice: "(mother(john, %grandchild)". This choice does not work either because the fourth statement is the only one whose head is "mother" and "mother(john, %grandchild)" cannot match "mother(jane,alice)".

So PROLOG backtracks further and tries to solve the first goal of the expanded statement again.

First, it tries to match "father(bill, %z)" with the second statement but fails. Then it tries to match "father (bill, %z)" with the third statement, and this time succeeds by setting "%z = jane". Now PROLOG attempts to solve the second part of the expanded statement, which is a choice between "father(jane, %grandchild)" and "mother(jane, %grandchild)". Once again PROLOG attempts to solve "father(jane, %grandchild)" first but fails. Then it attempts to solve "mother(jane, %grandchild)". This time it succeeds by matching "mother (jane, %grandchild)" and setting "%grandchild = alice".

PROLOG now tries to solve the last goal in the original question, which is now "pretty(alice)". This goal matches the sixth statement, so "%grandchild = alice" is an answer to the original question.

Controlling Robots

Now consider how a PROLOG program could be used to control a robot. Assume that a human and a robot are inside a rocket that has landed on the surface of a planet. The rocket has an airlock. On the planet there is a building that contains rocket fuel. There is also a cave with a key to the building. The cave also contains gold. The robot is able to lift the key, the fuel, or the gold (but it cannot lift the rocket). This situation can be described in PROLOG as shown in listing 2.

The statements in listing 2 represent the state of the robot's environment. As the robot interacts with the environment, some of the statements may cease to be true. To keep the description of the environment up to date you must have a way to delete statements no longer true. PROLOG provides a built-in function, called *delete*, to eliminate specified statements; another built-in function, called *assert*, can be used to add statements.

Now you can specify commands for the robot to attempt to obey. The first command will make the robot *fetch* an object to a specified place (see listing 3a).

The first subgoal, "inside(%object, %place)", checks to see if the object is already where you want it. If it is, the robot does not need to do anything. If it isn't, the robot must pick up the object, move to the required place and drop it. Note that the terms "pickup(%object)", "moveto (%place)", and "drop(%object)" have been grouped together within parentheses to show that the semicolon operator applies to all of them.

In order for the robot to *pick up* an object (see listing 3b), the object must be liftable. The robot must move to the place where the object is in order to pick it up. Assuming that the robot can carry only one thing at a time, it must be empty-handed when it picks up an object.

Listing 2: *Hypothetical environment found in a simulated space expedition. Through a series of commands specified in listing 3, a robot can be made to perform complex tasks, such as exiting the craft, and finding and returning with fuel—all with a simple instruction from the user.*

```
inside(human,rocket).
inside(robot,rocket).
inside(fuel,building).
inside(key,cave).
inside(gold,cave).
entrance(airlock,rocket).
entrance(door,building).
entrance(hole,cave).
closed(airlock).
closed(door).
liftable(key).
liftable(fuel).
liftable(gold).
```

Listing 3: *Fundamental commands built to control the hypothetical robot. In each case, the commands are constructed of goals and subgoals that are either basic enough for the robot to perform directly or are further broken into subgoals.*

3a
```
fetch(%object,%place)<- inside(%object,%place);
                         (pickup(%object),moveto(%place),drop(%object)).
```

3b
```
pickup(%object)<- liftable(%object),
                  inside(%object,%place),moveto(%place),
                  emptyhanded,assert(holding(%object)).
```

3c
```
emptyhanded <- (holding(%object),drop(%object));true.
```

3d
```
drop(%object)<- delete(holding(%object)).
```

3e
```
moveto(%place)<- inside(robot,%place);
                 (inside(robot,%place2),leave(%place2),enter(%place));
                 (outside(robot),enter(%place)).
```

3f
```
leave(%place)<- entrance(%x,%place),((closed(%x),open(%x));true),
                delete(inside(robot,%place),assert(outside(robot)),
                ((holding(%object),delete(inside(%object,%place)),
                assert(outside(%object)));true).

enter(%place)<- entrance(%x,%place),((closed(%x),open(%x));true),
                delete(outside(robot)),assert(inside(robot,%place)),
                ((holding(%object),delete(outside(%object)),
                assert(inside(%object,%place)));true).
```

3g
```
open(door)<- (holding(key);(inside(key,%place),pickup(key),leave(%place))),
             delete(closed(door)).
```

Finally, you must assert that the robot is now holding the object.

In order to be *empty-handed*, the robot must drop whatever it is holding (see listing 3c). If it is not holding anything, it is already empty-handed, so the built-in true function (which always succeeds) is executed.

When the robot *drops* something, you must delete the statement that says it is holding the object (see listing 3d).

Depending on where the robot is located initially, there are three possible actions that the robot must perform to *move* to a specified place (see listing 3e).

- If it is already at the specified place, it does not need to do anything.
- If it is inside some other place, it must leave that place and enter the specified place.
- If it is already outside, it must enter the specified place.

To leave a place (see listing 3f), if the entrance is closed, the robot must open the entrance. You must also remember to delete the fact that the robot is inside the place, and assert that the robot is now outside. If the robot is holding something, you must assert that the object also moves outside. Entering a place is accomplished similarly. To open the door to the building, the robot must either be holding the key or it must pick up the key (see listing 3g). Assume the robot can open the rocket's airlock automatically:

open(airlock ← delete(closed(airlock)).

Now you can order the robot to fetch the gold to the rocket with the command:

fetch(gold,rocket)?

The robot will leave the rocket, enter the cave, pick up the gold, and return to the rocket. If you ask the robot to fetch the fuel from the building by typing:

fetch(fuel,rocket)?

the robot will leave the rocket and try to enter the building. To do this it needs the key, so it will go to the cave to get it. Once it is in the building, it will drop the key and pick up the fuel. Finally, it will return to the rocket with the fuel. At this point, the PROLOG statements describing the "environment" will be as shown in listing 4. Note that the airlock and the door to the building are left open because the robot did not bother to close them.

This robot is not very bright. If, starting with the initial situation, for instance, you ask the robot to move the gold from the cave to the building (fetch(gold, building)?), it will go to the cave, pick up the gold, and go to the building. At this point the robot realizes it needs the key to open the door, so it returns to the cave to get the key. Since it can carry only one thing at a time, it drops the gold and picks up the key. It then returns to the door, opens it, and enters the building. It now thinks it has succeeded in moving the gold to the building, but the gold is still sitting in the cave where the robot dropped it. This problem is caused by the fact the robot may undo part of the overall goal by backtracking to accomplish a subgoal.

A Modest Proposal

It would not be too difficult to make the robot intelligent enough to handle the above problem. But instead of making the robot more intelligent, let's give it some "consciousness." Any robot worth its positronic brain must obey the three laws of robotics as postulated by Isaac Asimov (see reference 1). These laws are:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey orders given it by human beings except where such orders would conflict with the first law.
3. A robot must protect its own existence as long as such protection does not conflict with the first or second law.

In order to obey these laws, a robot must not simply obey commands blindly. It must first determine whether it can perform the command without violating the laws.

Listing 4: *Status of the hypothetical space expedition's environment after the robot has accomplished its tasks.*

```
inside(human,rocket).
inside(robot,rocket).
inside(fuel,rocket).
inside(gold,rocket).
inside(key,building).
entrace(airlock,rocket).
entrance(door,building).
entrance(hole,cave).
liftable(key).
liftable(fuel).
liftable(gold).
```


Listing 5: *Asimov's three rules of robotics as implemented in PROLOG. These rules allow the robot to protect humans by shooting aliens, and even by injuring itself, should the situation warrant. The application of the "mini-interpreter"* obey *makes this a simple proposition for PROLOG.*

```
obey((%p,%s))<- !,obey(%p),obey(%s).
obey((%p;%s))<- !,obey(%p);obey(%s).
obey(%goal)<- clause(%goal,%subgoals),protect(human),protect(robot),
              obey(%subgoals),!.
protect(%x)<- (in_danger(%x,%danger),eliminate(%danger));true.
in_danger(%x,alien)<- not(injured(alien)),inside(alien,%place),
                      inside(%x,%place).
eliminate(%danger)<- shoot(%danger).
shoot(%x)<- %x<>human,inside(%x,%place),moveto(%place),assert(injured(%x)).
```

This is easy to do in PROLOG (statements in listing 5 are explained individually below). Rather than issuing a command such as " fetch(fuel,rocket)?" you must now tell the robot to:

obey(fetch(fuel,rocket))?

"Obey" is a "mini-interpreter" for PROLOG that checks to see whether the human or the robot needs protecting before executing the subgoals associated with a goal. (Comments in PROLOG are surrounded by /* and */.) For example:

/* If a command consists of two subcommands, execute them one after the other*/

obey((%p,%s)) — !,obey(%p),obey(%s).

The exclamation point is a signal to PROLOG that if backtracking causes a return to that point, then the parent goal should be failed immediately, rather than trying to find another solution. This is used here to insure that "obey" does not introduce any extra backtracking.

/* If the command consists of a choice between two commands, execute one or the other of them */

obey((%p;%s)) — !,obey(%p);obey(%s).

If there is only one command and also a statement that matches it, protect the human and robot and then execute the subgoals associated with the goal. Note that *clause* is a built-in function. "Clause(%goal,%subgoals)" will return the subgoals associated with a goal):

obey(%goal) — clause(%goal,%subgoals),
protect(human),protect(robot),obey(%subgoals),!.

/* If the command is a built-in function, execute it */
obey(%p) — %p,!.

protect(%x) — (in_danger(%x,%danger),
eliminate(%danger));true.

Now let there be an alien in the building who, as long as he is not injured, will attempt to injure anything in the same place as he is:

inside(alien,building).

in_danger(%x,alien) — not(injured(alien)),
inside(alien,%place),inside(%x,place).

Assume also that the robot has a phasor and will use it to eliminate danger:

eliminate(%danger) — shoot(%danger).

Anything that is shot is injured. However, under no circumstances will the robot shoot a human:

shoot(%x) — %x < > human,inside(%x,%place),
moveto(%place),assert(injured(%x)).

Now if you tell the robot the fetch the fuel to the rocket:

obey(fetch(fuel,rocket))?

the robot enters the building and shoots the alien in order to protect itself. The robot then carries the fuel to the rocket. If you ask the robot to shoot the human:

obey(shoot)human))?

the robot will not obey because that would violate the first law. However, if you ask the robot to shoot itself:

obey(shoot)robot))?

it will do so because the second law of robotics takes precedence over the third.

I hope that this brief introduction has given you an indication of the simplicity and power of nonprocedural languages such as PROLOG. Such languages may represent the next step in the evolution of programming languages. ■

References/Suggested Reading

1. Asimov, Isaac. *I, Robot.* New York: Doubleday, 1957.
2. Kowalski, R. *Logic for Problem Solving.* New York: Elsevier-North Holland Publishing Co, 1979.
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PS—A FORTH-Like Threaded Language, Part 2

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Last month, we began the definition of a language called PS that has its roots in the threaded language FORTH. PS was designed to overcome some of the limitations of FORTH: in particular, its awkward approach to assembly-language definitions and its inability to accept forward references (ie: references to words that have not yet been defined). We looked at the overall structure of the PS interpreter/compiler and defined a few words. Now we will look at how PS behaves.

PS Syntax

PS, like FORTH, uses punctuation in some of its words, which makes representing them in text a difficult problem. To decrease the chance of confusion while trying not to clutter text unnecessarily, we will sparingly use braces, { }, to isolate the character string within as a PS word or phrase. Braces will be used only under the following situations:

- *when the material being quoted is a phrase of PS words (eg: { 26 LOAD } or { 3 5 + })*
- *with the PS words { , } (comma), { : } (colon), { ; } (semicolon), { ! } (exclamation point), { ' } (single quote mark), { " } (double quote mark), { [} (left bracket), and {] } (right bracket)*
- *with any word using the above punctuation marks (eg: { ." })*

All other PS words will be set apart by a space on either side of the word. So, in this article, braces will always signal a PS word or phrase. The braces are not part of the word or phrase, and PS words will never use braces within the body of a figure or listing....GW

An Example of PS Programming

With the information from part 1 of this article, we can encode a low-level program as a series of byte constants, mixed with names of variables, arrays, strings, labels, and some auxiliary words. PS words are given, followed by an explanation of their effect:

[
(Sets execute mode to construct machine-language instructions.)

ORIGIN 1111
(Starts compilation from the hexadecimal memory location 1111.)

BCONST LDA # AD
(Defines instruction "load accumulator from memory, direct addressing mode" as the hexadecimal constant AD.)

BCONST STA # 8D
(Defines instruction "store accumulator in memory, direct addressing mode" as the hexadecimal constant 8D.)

VAR SOURCE 021
(Defines a 16-bit variable called SOURCE containing the value hexadecimal 21 after compilation.)

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ARRAY DESTINATION 0100
(Defines an array called DESTINATION; it occupies hexadecimal 100 (decimal 256) bytes.

(The effect of the above code is shown in table 1a.)

ORIGIN 2222
LABEL DO.SOMETHING
LDA SOURCE
(LDA compiles the hexadecimal constant AD into location 2222, and SOURCE pushes the *address* of the variable into location 2223.)

STA DESTINATION 04 +
(STA compiles the constant 8D into location 2224; the rest of the phrase pushes the address of the first element of the array onto the stack and adds 4 to it. Thus, the instruction code followed by the necessary address is compiled.)

]
(Sets compile mode.)

SOURCE @ 0 = IF ." SOURCE CONTENT IS ZERO" ELSE -> DO.SOMETHING ENDIF
(At run time, this part of the program checks the contents of the variable SOURCE and jumps to the label DO.SOMETHING if the contents are nonzero. Otherwise, the message "SOURCE CONTENT IS ZERO" is displayed and execution continues. See the following section on control structures and the glossary definition of the PS word -> , pronounced "jump to.")

[
(Sets execute mode.)

RTS

(1a)

Compiled Code Address (Hexadecimal)	Contents	Dictionary of Defined Words	
1111	JSR PSH8	name:	LDA
1114	AD (hexadecimal)	value:	1111
1115	JSR PSH8	name:	STA
1118	8D (hexadecimal)	value:	1115
1119	JSR PSHA	name:	SOURCE
111C	0021 (hexadecimal)	value:	1119
111E	JSR PSHA	name:	DESTINATION
		value:	111E
1121-1220	space for the array DESTINATION	name:	DO.SOMETHING
		value:	2222

(1b)

Address (Hexadecimal)	Contents
2222	AD (LDA instruction code)
2223	111C (address of variable SOURCE)
2225	8D (STA instruction code)
2226	1125 (address of the array DESTINATION + 4)
2228	JSR SOURCE (SOURCE stands for 1119)
222C	JSR @
222F	JSR PSHN
2232	0000 (to be pushed at execution time)
2234	JSR =
2237	JSR IFNOT
223A	2259 (address of the false path)
223C	JSR TYPE.STRING
223F	16 (byte count of the following string, 22 decimal)
2240 -2255	ASCII for "SOURCE CONTENT IS ZERO")
2256	JMP 225C (address of the code after ENDIF)
2259	JMP DO.SOMETHING (DO.SOMETHING stands for 2222)
225C	60 (RTS instruction code)

Table 1: *The representation in memory of some PS code from the beginning of this article. Table 1a shows the representation of two 1-byte constants, LDA and STA, the variable SOURCE, and the 256-byte array DESTINATION. PSH8, PSHA, PSHN, @, and = are labels to the PS words of the same name (defined in the PS glossary at the end of this article). Table 1b shows the representation of the word DO.SOMETHING.*

("Return-from-subroutine" instruction is compiled.)

(The effect of the above words is shown in table 1b.)

Stack operations and control structures can now be easily used in a low-level program. You need only switch to the compile mode before the high-level part of the definition and switch back to the execute mode afterward, since the computer instructions and addresses are compiled while in execute mode. This is the principal benefit of identifying the code area with the parameter stack: in the execute mode, you can generate object code directly, instead of being at the mercy of the compiler.

When PS hits DO.SOMETHING in the execute mode, it calls the subroutine at hexadecimal address 2222; when the routine beginning at hexadecimal 2222 ends with an RTS (return-from-subroutine) instruction, control is returned to the text interpreter. If PS hits DO.SOMETHING in compile mode, it compiles JSR 2222 and increments the code pointer by 3.

Control Structures

Any system with some versatility must support conditional and iterative execution of code segments. The stack is a handy tool to pass parameters such as data or addresses, and it can also be used to pass the result of a condition test. The FORTH convention is to push zero (0000) onto the top of the stack if a condition is false and nonzero if it is true.

PS's primary conditional word is IF, which checks the top of the parameter stack for a true (nonzero) value. If the value is nonzero, the part of the program after IF is executed. Otherwise, control jumps over this section of the program. To mark the part of the program to jump to if the flag is false, the word ENDIF is used, which stores the jump address at compilation time in a location directly after IF.

The words IF and ENDIF are used as:

<check top-of-stack> IF *<code executed if top is true (nonzero)>*
ENDIF
<additional code>

If both true and false paths are required, the word ELSE may be added:

<check top-of-stack> IF *<code executed if top is true (nonzero)>*
ELSE *<code executed if top is false (zero)>*
ENDIF
<additional code>

At compilation time, ELSE stores the address of its false-branch code directly after IF and informs ENDIF where to compile the address of the additional code (that is, as the address field of a JMP instruction at the end of the true-branch code). In the example compilation of an

{ IF ... ELSE ... THEN } construct in table 1b, the code from hexadecimal 223C through 2255 is the true-branch code, the code from 2259 through 225B is the false-branch code, the constant at 223A points to the false-branch code, and the JMP instruction and constant at 2256 through 2258 cause the true-branch code to jump to the additional code past the ENDIF .

For example, the following program:

```
KEY DUP 030 < OVER 039 > OR IF  ." NON-
NUMBER KEY" ELSE ." NUMBER KEY" ENDIF
```

displays the message "NON-NUMBER KEY" if the ASCII code of the key pressed is less than hexadecimal 030 (the code of "0") or greater than hexadecimal 039 (the code of "9"). Otherwise, the message "NUMBER KEY" is displayed.

To repeat part of the program until a true flag is left on top of the stack, the words BEGIN and UNTIL can be used. For example:

```
BEGIN KEY 30 = UNTIL
```

loops until a zero is typed.

We can introduce all the other control structures used in FORTH. The possible implementation of the control structures in PS is described in more detail in the glossary definitions of IF , ELSE , ENDIF , BEGIN , UNTIL , AGAIN , DO , and LOOP . The computer stack is used at compilation time to pass data from the first conditional word to the following one. The computer stack is also used for loop control at run time.

[*I had some questions whether the above control constructs could be used in the definition of assembly-language definitions. According to the author, "The special words { BEGIN ... AGAIN } are used in exactly the same way as in high-level definitions. { IF ... ELSE ... ENDIF } or { DO ... LOOP } can also be used as in high-level definitions if the code before IF or DO pushes the result of a comparison or loop limits, respectively, onto the parameter stack at run time,"* ....GW]

High-Level Programming in PS

A high-level program is constructed from the stack operations and previously defined words.

In general, to define a new word, we must switch to the compile mode and resolve forward references, if necessary. If the word to be defined was not referred to before, a new dictionary entry is made, setting the type of the word to "defined" and setting V (the dictionary entry's value field) equal to the current code pointer.

To make sure that the control structures in the definition of a new word are used properly, we also might want to clear the IF counter to zero (see the glossary definitions of the control structures). To do that, we can start a high-level definition with:

```
[ LABEL <name> 0 IF-COUNTER C! ...
```

or we can introduce a separate word for starting high-level definitions. The FORTH word colon ({ : }) is used for this function.

In general, we need to end a high-level definition with an RTS instruction in order to use a high-level word as a subroutine. We can also verify that the control structures used in the high-level definition are balanced—that is, for every IF there is an ENDIF and vice versa. It is also a good idea to end by switching to the execute mode so some auxiliary actions can be performed between high-level definitions. A special word represented by the semicolon ({ ; }) does all that. For example, in:

```
: TWO.PLUS.TWO    02 02 + ;
```

the word { : } creates a new dictionary entry for the word TWO.PLUS.TWO with its T (type) entry in the dictionary equal to "defined" and its V (value) entry equal to *xxxx* where *xxxx* is the address of the compiled code. The definition for TWO.PLUS.TWO looks like this:

```
JSR PSHN
0002
JSR PSHN
0002
JSR "+"
RTS
```


where JSR and RTS represent machine-instruction codes, PSHN and "+" represent the addresses of the subroutines PSHN and + , and RTS is compiled by the word { ; }.

The word { : } is not special, for it is executed in execute mode, and { ; } is special, since it *must* be executed while in compile mode.

To define a special word, we could simply set the type of the most recently defined word to "special." But it is better to have a separate word similar to { : } to prevent forward references to special words. Indeed, it does not make sense to refer to an undefined special word, because special words are executed immediately whenever they are hit by the PS. For example, the special words { [} (set execute mode) and {] } (set compile mode) can be defined as follows:

```
:: [    00 MODE.FLAG C!  ;
:: ]    01 MODE.FLAG C!  ;
```

where :: is a word that denotes the beginning of a special word definition and MODE.FLAG is a variable checked by the text interpreter every time a new word is read from the text.

Conclusions

The main purpose of this article is to attract attention to FORTH and some problems that are not clearly solved in FORTH.

The solutions outlined here can be used to design new general-purpose programming systems. A problem-oriented system could be based on a general-purpose one and still retain all its capabilities.

Hardware designers could also benefit from FORTH concepts. If an instruction set included stack operations such as DUP , + , @ , and { ! }, programming efforts would be drastically reduced because it is nicer to work with the stack data than to do nit-picking with registers. Furthermore, the size of an operating system and its applications would be significantly reduced because 1-byte instruction codes could replace 3-byte calls to subroutines responsible for basic data processing like arithmetic, logic, fetch/store, and input/output operations.

The essential differences between PS and FORTH are that PS generates object codes (all PS words are machine-language subroutines), allows forward references, allows jumps to labels, and allows stack operations and high-level words to be used in the low-level code. Structurally, the PS dictionary is separate from the code. PS uses the free memory as a parameter stack and uses the computer stack for compilation of the control structures and for loop control.

The common features of PS and FORTH are use of the dictionary, stack operations, control structures, and the same notation for most auxiliary words.

PS's assembler is actually a set of byte constants that represents the instruction set of the computer. This feature significantly increases portability of the system and facilitates cross-compilation of programs written in PS.

It is difficult to think of a simpler general-purpose system than PS. It is actually an improved assembly language facilitating usage of the hardware capabilities. The main advantage of multilevel software is that, while equally convenient and portable as high-level software, it benefits from all the hardware potential. The more sophisticated the hardware, the more interesting the things that can be done with it. My experience with FORTH shows that software-hardware relations should be as tight as possible. (An interesting example of a system (E-machine) with a distributed short-term memory, in which hardware is actually inseparable from software, is described by Victor Eliashberg in "The concept of E-machine and the problem of context-dependent behaviour," TXU 40-302 US Copyright Office, 1980, pages 101 to 112.)■

References

1. FORTH Glossary (compiled by Gregg Williams). BYTE, August 1980, pages 186 through 196.
2. James, J S. "What Is FORTH? A Tutorial Introduction." BYTE, August 1980, pages 100 through 126.
3. Rather, E D and C H Moore. "The FORTH Approach to Operating Systems." *ACM 1976 Proceedings*, October 1976, pages 233 through 240.

PS Glossary

The glossary consists of two parts: stack operations and auxiliary words. The words in the first part are equivalent to their counterparts in FORTH; they are provided for readers not familiar with FORTH.

The notation used in some definitions should be interpreted similarly to the following example: "n1 n2 → n3" means "before the word is executed, n2 is on top of the stack and n1 is immediately below it; after the word is executed, both n1 and n2 have been replaced by n3." (The values n1, n2, and n3 are 16-bit data.) This notation says nothing about what (if anything) is under these entries on the stack.

Stack Operations

DUP — *Duplicates the 16-bit number on top of the parameter stack.*
n1 → n1 n1

DROP — *Drops the number from the top of the stack.*
n1 → *(empty)*

SWAP — *Exchanges the top two numbers on the stack.*
n1 n2 → n2 n1

OVER — *Places the copy of the second number onto the top of the parameter stack.*
n1 n2 → n1 n2 n1

ROT — *Rotates the top three numbers, placing the third one onto the top.*
n1 n2 n3 → n2 n3 n1

+ (add) — n1 n2 → n3, *where* n3 = n1 + n2.

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Continued from page 405:
− (subtract), * (multiply), and / (divide) — n1 n2 → n3, *analogous to the word* + , *above.*

AND (logical "and") — n1 n2 → n3, *where* n3 *is the bitwise logical "and" of* n1 *and* n2.

OR (logical "or") — n1 n2 → n3, *where* n3 *is the bitwise logical "or" of* n1 *and* n2.

NOT (logical "not") — n1 → n2, *where* n2 *is the one's complement of* n1.

= (equals) — n1 n2 → f, *where* f *is 0001 if* n1 = n2, *or 0000 otherwise.*

> (greater than) — n1 n2 → f, *where* f *is 0001 if* n1 > n2, *or 0000 otherwise.*

< (less than) — n1 n2 → f, *where* f *is 0001 if* n1 < n2, *or 0000 otherwise.*

@ (fetch) — n1 → n2, *where* n2 *is the 16-bit number held in the bytes at addresses* n1 *and* n1 + *1.*

[!] (store) — n1 n2 → *(empty), where the 16-bit number* n1 *is stored at the address* n2. *The numbers* n1 *and* n2 *are removed from the stack after the operation is performed.*

C@ (fetch a character) — n1 → *00*xx, *where* xx *is the 8-bit contents of the address* n1.

[C!] (store a character) — n1 n2 → *(empty), where the 8 least-significant bits of* n1 *are stored at the address* n2.

[+!] (plus-store) — n1 n2 → *(empty), where* n1 *is added to the 16-bit number held in the bytes at addresses* n2 *and* n2 + *1.*

KEY — *Waits until the next terminal key is struck and pushes its ASCII code (xx) onto the top of the parameter stack. (empty) → 00xx*

EMIT — *00xx →(empty), where the ASCII equivalent of* xx *is transmitted to the display, the printer, or some other selected output device.*

CR (carriage return) — *The same as 0D EMIT where hexadecimal 0D is the ASCII code for a carriage return.*

Auxiliary Words

[Editor's Note: *These words are unique to PS and do not behave as their FORTH equivalents. Like all PS words, these are actually machine-language subroutines that end with a return-from-subroutine instruction. While they are executing, the return stack of the microprocessor being used contains the return address of the current subroutine—in other words, the return address points to the next byte after the call of the PS word being executed. Sometimes, the PS word currently executing will manipulate or use this value....*GW]

ORIGIN (special word) — *Used as* [*ORIGIN* nnnn]. *Takes the following word, converts it to a 16-bit number, and sets the code pointer equal to this number.*

 # (special word—compiles an 8-bit number) — *Used as* [# nn]. *Converts the following word to a number and pushes its 8 least-significant bits into the code. Increments the code pointer by 1.*

NUMBER — *If the next word read from the input stream starts with a 0 or the minus sign, converts it to a 16-bit integer. In execute mode, pushes this number onto the stack as a parameter. In compile mode, compiles the sequence JSR PSHN* nnnn, *where* nnnn *is the 16-bit converted signed integer.*

PSHN (push number) — *Pushes the contents of the return address (a 16-bit number) into the code and increments the return address by 2. Compiled by NUMBER.*

LINK — *Pushes the value of the V field into the code and sets the V field of the word to the code pointer decremented by 2. Used to link references to an undefined word, as shown in part 1 of the article.*

RESOLVE — *Resolves forward references to the word being defined, sets the type of the word to "defined," and sets the V field of the word equal to the code pointer. Used to store the value of the word being defined into locations where this word has already been referenced.*

: (defines a high-level word) — *Reads the next word, sets IF counter to 0, and switches to compile mode. If the word has been previously used, resolves forward references; if it has not, makes a new dictionary entry. In either case, sets its V field equal to the value of the code pointer and sets the type to "defined."*

; (special word—end of a colon definition) — *Compiles an RTS instruction, switches to execute mode, verifies that the control structures are balanced—that the IF counter is equal to 0—and generates an error message if it is not.*

:: (defines a special word) — *Reads the next word, sets IF counter to 0, switches to compile mode, makes a new entry in the dictionary for the word, sets its T (type) field to "special," sets its V (value) field to the value of the code pointer.*

IF (special word) — *Increments the IF counter, compiles the instruction JSR IFNOT, pushes the value of the current code pointer onto the computer stack, pushes a temporary dummy address of 0000 into the code.*

IFNOT — *If the top of the parameter stack is 0, jumps to the address specified by the 2 bytes pointed to by the return address. Otherwise, increments the return address by 2 and returns. Compiled by IF and UNTIL.*

ELSE (special word) — *Checks that the IF counter is greater than 0, compiles JMP 0000, stores the value of the code pointer into the 2-byte location pointed to by the address on the top of the stack (left by the previous IF statement), and pushes the code pointer decremented by 2 onto the computer stack.*

ENDIF (special word) — *Checks that the IF counter is greater than 0, decrements it, and stores the code pointer into the 2-byte location pointed to by the address on the top of the stack (left by the previous IF or ELSE statement).*

BEGIN (special word) — *Increments the IF counter and pushes the value of the code pointer onto the computer stack.*

AGAIN (special word) — *Verifies that the IF counter is greater than 0, decrements it, compiles a JMP instruction, and pushes the address from the computer stack (left there by the previous BEGIN) into the code.*

UNTIL (special word) — *Verifies that the IF counter is greater than 0, decrements it, compiles JSR IFNOT, and pushes the address from the computer stack (left by the previous BEGIN) into the code.*

DO (special word) — *Used as* [n m *DO ... LOOP*], *with the initial value of the index* n *and loop limit* m. *Compiles the instruction JSR RUN.TIME.DO (which pushes* n *and* m *at run time from the parameter stack onto the computer stack), pushes the code pointer onto the computer stack, and increments the IF counter.*

RUN.TIME.LOOP — *Increments* n *(see the previous definition). If* n = m *(both numbers are on the computer stack), increments the return address by 2 and returns. If* n < m, *jumps to the address specified by the 2 bytes pointed to by the return address. Compiled by LOOP.*

LOOP (special word) — *Checks that the IF counter is greater than 0, decrements it, compiles JSR RUN.TIME.LOOP, and pushes the address from the computer stack (left by the previous DO) into the code.*

LABEL (special word) — *Reads the next word. If the word has been previously used, resolves forward references; if it has not, makes a new dictionary entry. In either case, sets its V field to the value of the code pointer and sets the type to "defined."*

– > (special word) — *Reads the next word and pushes a JMP instruction into the code. If the word is undefined but previously used, links this forward reference to the previous ones. If it is a new word, makes an entry, sets the type to "undefined," sets the V field to the value of the code pointer, and pushes 0000 into the code. If it is a defined word, pushes*

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the value of the V field into the code.

PSHN (push number) — *Pushes the contents of the return address (16-bit data) onto the parameter stack and drops the return address from the computer stack. Compiled by CONST.*

PSH8 (push 8-bit data) — *The same as PSHN, but an 8-bit quantity is pushed onto the parameter stack and drops the return address from the computer stack. Compiled by BCONST.*

PSHA (push address) — *Pushes the return address onto the parameter stack and drops the return address from the computer stack. Compiled by VAR.*

VAR (variable) — *Used as* { *VAR* <*name*> nnnn } *or* { *VAR* <*name*> # nn }. *Reads the next word. If it has been previously used, resolves forward references; if it has not, makes a new dictionary entry. In either case, sets the type to "defined," sets its V field to the value of the code pointer, and compiles the instructions JSR PSHA.*

CONST (constant) — *Used as* { *CONST* <*name*> nnnn }. *Reads the next word. If it has been previously used, resolves forward references; if it has not, makes a new dictionary entry. In either case, sets the type to "defined," sets its V field to the value of the code pointer, and compiles the instructions JSR PSHN.*

BCONST (byte constant) — *Used as* { *BCONST* <*name*> # *nn* }. *Reads the next word. If it has been previously used, resolves forward references; if it has not, makes a new dictionary entry. In either case, sets the type to "defined," sets the V field to the value of the code pointer, and compiles the instructions JSR PSH8.*

ARRAY — *Used as* { *ARRAY* <*name*> nnnn }. *Reads the next word. If it has been previously used, resolves forward references; if it has not, makes a new dictionary entry. In either case, sets the type to "defined," sets the V field equal to the value of the code pointer, compiles the instructions JSR PSHA, reads the next word, converts it to a number, and increments the code pointer by this number.*

{ " } **(special word)** — *Reads the text from the input stream until another quote is hit and compiles the following:* <*byte count*> <*the string of characters just entered*>.

TYPE.STRING — *Types a string located at the return address and increments the return address by the byte count plus 1 and returns. This word is compiled by the word "dot-quote" ({ ." }) before* <*byte count*> <*string*>.

." (special word) — *Reads the text from the input stream until a quote (") is hit. If PS is in execute mode, types the string— that is, sends it to the printer or other display device. If PS is in compile mode, compiles the instructions JSR TYPE.STRING* <*byte count*> <*string*> *(this will type the string at run time). An example is* { ." *IMMEDIATELY PRINT THIS SENTENCE"* }.

{ [} **(special word)** — *Sets the system variable MODE.FLAG to 00 to signal that the system is now in the execute mode.*

{] } **(special word)** — *Sets the system variable MODE.FLAG to 01 to signal that the system is now in the compile mode.*

A View from the Lectern: What's Wrong with Technical Writing Today?

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Last year, BYTE Editor in Chief Chris Morgan spoke out on the topic "What's Wrong with Technical Writing Today?" (December 1980 BYTE, page 6). As a technical writer and, more importantly, as a professor of technical writing at a four-year engineering-technology college, I read his editorial with a great deal of interest and agreement. What follows is a view from the lectern: in other words, what's wrong with technical writing today as I see it from the college classroom.

Morgan's Laws

Everything that Mr Morgan mentioned as essential to technical writing is in the typical college-level technical writing course. What Mr Morgan calls "knowing your audience" instructors call "audience analysis." What Mr Morgan calls his Laws comprise the fundamentals for any technical writing text, except that he expresses them with a great deal more succinctness and humor than do most textbooks. While I agree wholeheartedly with his Laws, I'll expand on them a bit before addressing the central question of his editorial.

Morgan's Law #1: No Writer Ever Got Shot Down for Writing Too Clearly. Corollary 1.1: Nor Did Any Writer Ever Get Shot Down for Writing Too Simply. Many people falsely think that they need to sound erudite and learned (read "pompous and unintelligible") for fear of being pedestrian and primitive (read "clear and concise"). All too often writing is peppered with fancy five-dollar words when the simple fifty-cent variety does the job more effectively. We can talk about "readability formulas," and there are several (including those of Rudolf Flesch and Robert Gunning), but all they do is show the writer whether he is writing on a level that bypasses most of his readers.

Morgan's Law #2: The Beginning is Half the Thing. Corollary 2.1: The Summary is the Major Thing. While it only represents one-tenth or less of the report, it contains the seeds of the entire work, including the conclusion or recommendation, if one is required. Everyone reads the summary; then the audience picks and chooses what it needs from the rest of the report. Yet how many technical reports, memos, or articles contain that essential summary up front where it belongs? And how many times have you had to wade through the entire report to see what the results are?

Morgan's Law #3: Avoid the Penguin Syndrome. (Tell your readers what they need to know, and no more.) Corollary 3.1: Then Use Appropriate Headings to Tell Them What to Expect. These are, or should be, the road markers to the report or article. Their purpose is to let your reader know *before* he reads your report what information is contained in each section and whether that information is important to him. Many reports have headings but few have enough to keep the reader on course.

Morgan's Law #4: Writing is Nonlinear. (Absolutely.) Corollary 4.1: Who *really* writes an outline? I don't, and I suspect that many others who write don't either. But everyone is afraid to admit it, thinking his writing will be labeled disorganized if he doesn't have a clearly planned outline before he writes. Case in point: I'm presently typing this article as the thoughts come to me. Sure, I'm using Mr Morgan's article as a starting point (in much the same way that one might use data or research or personal experience in writing), but beyond the notion that I have something to say, I'm not sure yet how it will all get said or where it will end up. Later, I will surely cut and paste, taking out some parts and expanding others, but the piece will remain essentially as it is, which confirms Morgan's Law #4.

Very few people know exactly where they're going until they get going; then the road bends and curves and they steer along it following the natural turns. Yet almost all the textbooks include and emphasize outlining (the highly structured, traditional kind) as the way to plan one's technical writing. True, one needs some sense of direction or purpose in writing, but the first draft should be given a mind of its own.

Morgan's Law #5: (The Three Foot Rule): Don't Write Anything Unless You have a Dictionary and a Thesaurus Within Three Feet of You. Corollary 5.1: Having Them Nearby Is the First Step; Using Them is the Second. Proximity of reach does not guarantee use.

Corollary 5.2: Use the Thesaurus with Caution. You must know the word you're substituting another word for. Otherwise, how can you be sure the substituted word is an accurate synonym? Keep in mind, too, that the thesaurus is more often abused than correctly used. Some writers like to "upgrade" their vocabulary, picking out fancy-sounding words for the perfectly simple and clear ones. You might try substituting a good handbook of grammar for the thesaurus and make that your number two source book.

Morgan's Law #6: Don't Be Afraid to Be Interesting. No addendum needed!

What's Wrong with Technical Writing?

With Morgan's Laws as a reference point, I'll now address, from a classroom perspective, Mr Morgan's initial question—What's Wrong With Technical Writing Today?

What's basically wrong is that students aren't interested in technical writing—at least not while they're students. What they *are* interested in is technology and science and computers and engineering. BYTE and *Omni* sell out each month in the campus bookstore, and issues of the student newspaper focus on different technical problems—such as the environment, economics, alternate energy sources, and nuclear power. But students hate to write, they cannot write well or easily, and they think they'll never have to write in "the real world." Their favorite line is: "Why do I need to know grammar or how to spell? My secretary will take care of all that."

Today's Technical Students

Technical students are very curious about things mechanical and mathematical, but they hate and are afraid to put pen to paper. They have good reason for both emotions. Instead of encouraging good writing most high schools, unknowingly, do the opposite. In the permissive 1970s, the schools stopped requiring English courses beyond the ninth grade or adopted "creative" writing courses that asked students to *emote* rather than *denote*. These touch-and-feel creative seminars ignored discrepancies in grammar, syntax, and spelling for fear of alienating the student. And students do not read. Their vocabularies are limited by their exposure to television and rock music.

When these students reach college, they're knocked out of their chairs during the first week of Freshman Composition (FC) with Fs on their papers for all the things they were never told or didn't bother to remember in high school. Other students don't make it directly to FC but must first master remedial programs, from which only a limited number escape. Those who do and then survive FC move into the upper levels of academe, where they take Technical Writing along with other technical courses. At this point, the students feel even less sure of their writing abilities and less willing to believe that they'll ever need to do anything so abhorrent as write memos, articles, and reports.

Languages Forum

In the Classroom

So what happens in the classroom? Not much until the first papers are returned. In my technical writing class, I spend the first three weeks talking about the language and style of technical writing, the types, the methods of organization based on proper audience analysis, and the need for conciseness in writing and meticulousness in editing and proofreading. I entertain with examples of horrid writing, I instruct with handouts of organizational patterns, and I inform with case problems which students work in class and which we then discuss. Finally, they write their first report. Almost all fail.

Now they want to listen, but not for the value that such information will provide in their future careers. Rather, they listen so that they can make the grade that will get them *out* of the course. And in the evaluations that I receive at the end of the quarter, they repeatedly complain that I require too much work for a three-hour course.

Teacher as Missionary

I, of course, pay no attention to my students' complaints, for I'm on a mission of sorts. I have them for only one quarter and then for only three hours a week for ten weeks. After they leave my class and the college, they will become the engineers and technologists of the future. They will build the technologies that I will use. They will implement the plans; they will set the procedures. And their efforts, their knowledge, their expertise is only as good as their ability to express it accurately and effectively and clearly to others. They don't know that, but I do. And that's the problem with technical writing today, as I see it.

Later, the students—now employees of companies and/or employers—discover this fact for themselves. They *do* have to write on the job—more than they realized or feared. But they don't have the skills to do the job well, and they can't remember what they learned in college because it didn't matter then. Some companies—more and more—recognize the problem and hire consultants to set up seminars to teach their people the skills they need. Others send them to an increasing number of management writing courses and continuing education programs.

And so, the process begins again. Only this time, it's for real.■

Languages Forum is a feature which is intended as an interactive dialog about the design and implementation of languages for personal computing. Statements and opinions submitted to this forum can be on any subject relevant to its purpose of fostering discussion and communication among BYTE readers on the subject of languages. We ask that all correspondents supply their full names and addresses to be printed with their commentaries. We also ask that correspondents supply their telephone numbers, which will not be printed.

Technical Forum

Where Am I? A Proposal for a New Microprocessor Instruction

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Few contemporary computers provide a single explicit instruction that returns its present location in memory. It is possible to find the address where an instruction is located by making a subroutine call and popping up the stack register, but this may require more than three instructions. When executed, a WAI (Where Am I?) instruction could leave the value of the PC (program counter) in the accumulator. Digital Equipment Corporation's VAX 11/780, which treats the PC as one of its registers, allows moving the value in the PC with the MOVE instruction, but the result is unpredictable. This is possibly due to the look-ahead feature it employs, and a similar situation could arise in computers that use pipelining.

With a WAI instruction, I could write relocatable machine code more easily on my Apple II. When I write a machine-language program starting at address 300 (hexadecimal) and need to store data (without using the stack facility) or refer to a subroutine starting 60 bytes after the starting address, the code no longer becomes relocatable, for, obviously, one has to use statements like JSR $#360, and this code cannot be located starting at, say, 400. (As mentioned before, one can implement WAI by making a subroutine call and using the stack pointer—this is the solution proposed in the *Apple Reference Manual*). Also, when circuit cards containing relocatable code in ROM (read-only memory) are plugged into one of the Apple's slots, they may need to know where they have been installed—without the user intervening—so that they may place appropriate address values in proper processor memory locations.

There must be a reason for the absence of this instruction. I hope other BYTE readers will present pros and cons for this instruction based on their hardware and software experience.■

Technical Forum is a feature intended as an interactive dialog on the technology of personal computing. The subject matter is open-ended, and the intent is to foster discussion and communication among readers of BYTE. We ask that all correspondents supply their full names and addresses to be printed with their commentaries. We also ask that correspondents supply their telephone numbers, which will not be printed.

Programming Quickies

WRITELONG

A Pascal Simulation of Long-Integer Output

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Imagine you are programming output for a spread sheet. Wishing to depict the product-by-product sales of apples, oranges, and pears in an analysis of monthly sales of S & S Fruit Stands Inc, you write in Pascal:

```
for i := jan to dec do
    write(round(apples[i]):10);
```

But S & S is a big company. Their monthly sales exceed the maximum integer possible in the target processor, which is 16 bits (the range −32768 to 32767). So the program crashes if you use the round function. If you don't use the round function, your output shows apple sales with a decimal point followed by zero, as in 55,765.0 apples.

Procedure WRITELONG will solve the problem if the Pascal version used does not have long integer conversion. As input it accepts a real number, "x", and a field-length specification, "flen". It splits the real number into two parts. A division and truncation, followed by remultiplication and subtraction from the original number, isolates the right part of the number from the left.

For a 6.5-digit precision floating-point number, the right part is fixed at three digits. If rounding of the right part yields a number longer than three digits, overflow is carried into the left (atrunc := atrunc + 1), and the right is reset. Occurrence of zeroes in the right part is filled in an *if...then...else* sequence that evaluates number ranges. For greater precisions, the right part could be extended to four digits, along with the *if...then...else* sequence.

The banishing of the decimal point has other possible solutions. A real-to-string conversion routine may prove more useful if you wish to position commas in the output. WRITELONG, however, has one small advantage: the algorithm depends upon neither the host processor nor a specific implementation of Pascal. ■

Listing 1: *Example of an application of the WRITELONG procedure in Pascal.*

```
program longtest;
var
    flen : integer;    {format field width}
    x : real;          {real 6.5-digit num}
    f : text;          {text file for i/o }
    s : string;        {file / device name}


procedure writelong(x : real; flen : integer);

var
    areal, breal : real;          {left and right parts of x }
    atrunc, brnd : integer;       {integerized parts of x    }

begin
    if x <= 32767.0 then          {MAXINT - 1}
        write(f,round(x):flen)
    else
        begin

            {get trunc of left part}
            areal := x / 1000.0;
            atrunc := trunc(areal);

            {get round of right part}
            areal := 1000.0 * atrunc;
            breal := x - areal;
            brnd := round(breal);

            if brnd > 999 then
               begin
                  {carry overflow to left}
                  atrunc := atrunc + 1;
                  {reset right}
                  brnd := brnd - 1000
               end;

            {write left part}
            write(f,atrunc:(flen-3));

            {fill and write right part}
            if brnd >= 100 then
                write(f,brnd)
            else
                if (brnd >= 10) and (brnd <= 99)
                    then write(f,'0',brnd)
            else
                if (brnd >= 1) and (brnd <= 9)
                    then write(f,'00',brnd)
            else
                write(f,'000');
        end;{>32767}

end; {writelong}



begin
 s := 'CON:';    {filename - CPM output to console}
 assign(f,s);    {Pascal MTPLUS fcb assignment    }
 rewrite(f);

 writeln;
 writeln('LONG INTEGER FORMAT OF REAL NUMBER');
 repeat
   write(f,'Enter X ');
   readln(x);
   write('Format length ');
   readln(flen);

   writeln(f,'SCALE:');
   writeln(f,'123456789x123456789x123456789x');
   writelong(x,flen);
   writeln(f);
 until x < 1.0;
end.
```

Listing 1 continued from page 95:

```
0370    EB          @        XCHG               ;
0371    E9          @        PCHL               ;JMP TO EVENT PRGM
                    @;
                    @;
                    @;
                    @;****************************************
                    @;
                    @;OVERFLOW ROUTINE:  DISABLES INTERRUPTS AND
                    @;CLOCK, OUTPUTS MESSAGE TO CONSOLE AND RETURNS
                    @;
                    @;
                    @;
0372    F3          @OVFLOW: DI                 ;DISABLE INTERRUPTS
0373    3E40        @        MVI     A,40H      ;DISARM SYSTEM CLOCK
0375    D306        @        OUT     6          ;
0377    21 037E     @        LXI     H,..MESS;
037A    CD 047A     @        CALL    MESSOUT    ;SEND MESSAGE
037D    C9          @        RET
                    @;
037E                @..MESS: .ASCIZ  /
037E    0D0A        @
0380    0D0A092A2A2A@        **************************************
03A9    0D0A        @
03AB    0D0A0953414D@        SAMPLING ABORTED:  PROCESSOR TOO SLOW!
03D4    0D0A09090920@                           BUFFER OVERFLOW !!!
03EF    0D0A        @
03F1    0D0A092A2A2A@        **************************************
041A    0D0A        @
041C    0D0A00      @/
                    @;

                             .INSERT B:FNXN
                    @;       ***************
                    @;       *             *
                    @;       *    FNXN     *
                    @;       *             *
                    @;       ***************
                    @;
                    @;THIS SR TAKES A 16-BIT NUMBER AND DIVIDES
                    @;IT BY 2*(REG A) NUMBER OF TIMES. ON ENTERING,
                    @;THIS SR EXPECTS HL TO POINT TO THE LOW BYTE
                    @;OF THE 2-BYTE NUMBER.  HIGH BYTE IS ASSUMED
                    @;TO BE AT (HL+1).  RETURN IS MADE WITH HL
                    @;POINTING TO THE LOW BYTE.  SIGN BIT OF LOW
                    @;BYTE IS COMPLEMENTED BEFORE RETURN.
                    @;
041F    B7          @FNXN:   ORA     A          ;PR CODE=0?
0420    2809        @        JRZ     ..CMPL
0422    23          @..LOOP: INX     H          ;
0423    CB3E        @        SRLR    M          ;DIVIDE BY TWO
0425    2B          @        DCX     H          ;
0426    CB1E        @        RARR    M          ;
0428    3D          @        DCR     A          ;
0429    20F7        @        JRNZ    ..LOOP     ;DIVIDE AGAIN?
042B    7E          @..CMPL: MOV     A,M        ;COMPL SIGN BIT
042C    EE80        @        XRI     128D       ;
042E    77          @        MOV     M,A        ;
042F    C9          @        RET
                    @;

                             .INSERT B:S$INIT
                    @;*********************************
                    @;*                               *
                    @;*  SAMPLING INITIATOR           *
                    @;*                               *
                    @;*********************************
                    @;
                    @;THIS ROUTINE INITIALIZES THE INTERRUPT
                    @;HANDLER, CLEARS THE TEMP BUFFERS, SETS
                    @;UP THE APPROPRIATE COUNTERS, ENABLES
                    @;INTERRUPTS AND THEN RETURNS. THE INTRRPT
                    @;VECTOR JAMMED ONTO THE BUS IS PRESUMED TO
                    @;BE OFFH.
                    @;
                    @;REGISTERS ARE NOT PRESERVED.
                    @;
                    @;WHEN CALLLED, THIS SR EXPECTS REGS DE
                    @;TO CONTAIN THE STARTING ADDR OF A TABLE
                    @;CONTAINING THESE PARAMETERS IN THIS
                    @;ORDER:
                    @;;
                    @;BYTE 0 :# CHANNELS TO SAMPLE (STARTING
                    @;                    AT 030Q)
                    @;BYTE 1 :# INTERRUPTS PER SAMPLE
                    @;BYTE 2 :# SAMPLES PER DATA POINT
                    @;
0430    D5          @INIT:   PUSH    D          ;TRANSFER PARAMETERS
0431    E1          @        POP     H          ;TO INTERNAL LOC
0432    11 0137     @        LXI     D,CHNL     ;
0435    EDA0        @        LDI                ;CHNL
0437    EDA0        @        LDI                ;# INTRPTS/SAMPLE
0439    EDA0        @        LDI                ;# SAMPLES/DATA PT
043B    2B          @        DCX     H          ;INITIALIZE SAMPLE CNTR
```

Listing 1 continued:

```
043C     EDA0       @        LDI              ;
                    @;
043E     D9         @        EXX              ;SET UP INTRPT CNTR
043F     3A 0138    @        LDA     INT$S    ;
0442     47         @        MOV     B,A      ;
0443     D9         @        EXX              ;
                    @;
0444     2A 0183    @        LHLD    NTMPAD   ;INITIALIZE BUFFERS
0447     0620       @        MVI     B,32D    ;WITH 00
0449     3E00       @        MVI     A,0      ;
044B     77         @..LOOP: MOV     M,A      ;LOOP TILL DONE
044C     23         @        INX     H        ;
044D     10FC       @        DJNZ    ..LOOP   ;
                    @;
                    @;SET UP INTERRUPT JUMP ADDRESS.  ASSUMES CLOCK
                    @;FLAG JUMPERED TO VI3.
                    @;
044F     ED46       @        IM0              ;INTRPT MODE = 2
0451     21 0018    @        LXI     H,18H    ;FILL IN JMP INSTR
0454     3EC3       @        MVI     A,0C3H   ;
0456     11 018E    @        LXI     D,INTHLD;
0459     77         @        MOV     M,A      ;
045A     23         @        INX     H        ;
045B     73         @        MOV     M,E      ;
045C     23         @        INX     H        ;
045D     72         @        MOV     M,D      ;
045E     3E50       @        MVI     A,50H    ;RESET CLOCK FLAG
0460     D306       @        OUT     6        ;
0462     3ECD       @        MVI     A,0C0H   ;ARM CLOCK INTRPT
0464     D306       @        OUT     6        ;
0466     FB         @        EI               ;ENABLE INTERRUPTS
0467     C9         @        RET              ;AND RETURN
                    @;
                             .INSERT B:P$INIT
                    @;*****************************************
                    @;*                                       *
                    @;*        PROCESSOR INITIALIZER          *
                    @;*                                       *
                    @;*****************************************
                    @;
                    @;ON ENTRY, THIS SR EXPECTS REG DE TO CONTAIN
                    @;THE STARTING ADDRESS OF A TABLE CONTAINING, IN
                    @;THIS SEQUENCE:
                    @;
                    @; BYTE  0        PROCESS CODE (USED BY "FNXN" TO
                    @;                DETERMINE HOW MANY HALVINGS TO
                    @;                DO
                    @;
                    @; BYTE  1        # OF PROGRAMMED EVENTS
                    @;
                    @; BYTES 2,3      TIME FOR EVENT #1 (#DATA PTS)
                    @;
                    @; BYTES 4,5      ADDR OF PRGM EXECUTING EVENT #1
                    @;
                    @; BYTES 6,7      TIME FOR EVENT #2
                    @;
                    @; BYTES 8,9      ADDR OF PRGM EXECUTING EVENT #2
                    @;
                    @; ...ETC... FOR ALL EVENT TIMES AND PRGM ADDR'S
                    @;
                    @;
                    @;REGISTERS ARE NOT PRESERVED;
                    @;PARAMETERS FROM THE TABLE ARE INSERTED BY THIS
                    @;ROUTINE INTO INTERNAL LOCATIONS OF PROCSR
                    @;FOR APPROPRIATE DATA PROCESSING AND TIMING
                    @;FUNCTIONS.
                    @;
0468     D5         @P$INIT: PUSH    D        ;TRANSFER PARAMETERS
0469     E1         @        POP     H        ;TO INTERNAL TABLES
046A     11 013B    @        LXI     D,DIVSR;
046D     EDA0       @        LDI              ;PROCESS CODE
046F     7E         @        MOV     A,M      ;
0470     EDA0       @        LDI              ;N$EVTS
0472     87         @        ADD     A        ;FORM BYTE COUNTER
0473     87         @        ADD     A        ; (=4*N$EVTS)
0474     0600       @        MVI     B,0      ;PUT IN BC
0476     4F         @        MOV     C,A      ;
0477     EDB0       @        LDIR             ;TRANSFER TIMES AND
                    @                         ;ADRR'S FOR ALL EVENTS
0479     C9         @        RET              ;

                             .INSERT B:MESSOUT
                    @;*********************************
                    @;*                               *
                    @;*          MESSOUT              *
                    @;*                               *
                    @;*********************************
                    @;
                    @;THIS SUBROUTINE OUTPUTS A MESSAGE TO THE
                    @;CONSOLE USING THE DOS 'COUT' ROUTINES AND
                    @;RETURNS CONTROL TO THE CALLING PROGRAM.
                    @;THE SUBROUTINE EXPECTS HL TO HOLD THE
```

Listing 1 continued on page 418

Listing 1 continued:

```
                        @;ADDRESS OF THE MESSAGE WHICH MUST BE
                        @;TERMINATED BY A NULL CHARACTER.
                        @;REGISTERS A,B,H,L ARE ALTERED IN THIS
                        @;ROUTINE.
                        @;
                        @;SYMBOL TABLE:
                        @;
200D                    @COUT = 200DH
                        @;
                        @;
047A    7E              @MESSOUT:MOV    A,M      ;GET CHARACTER
047B    B7              @        ORA    A        ;NULL CHARACTER?
047C    C8              @        RZ              ;YES,RETURN
047D    47              @        MOV    B,A      ;B<=A
047E    3E00            @        MVI    A,00     ;CLEAR ACC
0480    CD 200D         @        CALL   COUT     ;NO, OUT TO CRT
0483    23              @        INX    H        ;INCR POINTER
0484    C3 047A         @        JMP    MESSOUT  ;LOOP TILL NULL

                                 .INSERT B:DATWR
                        @;****************************************
                        @;**                                    **
                        @;**             DATWR                  **
                        @;**                                    **
                        @;****************************************
                        @;
                        @;THIS ROUTINE WRITES DATA OUT TO DISK 1 USING
                        @;THE PREVIOUSLY ESTABLISHED POINTERS OF THE
                        @;UTILITY PROGRAMS "PROCSR" AND "INTHDLR".
                        @;IT PLACES #CHANNELS AND #DATA POINTS AT THE
                        @;BEGINNING OF THE FILE (E.G. #CHNLS IN 0FFD;
                        @;BUFFER STARTS AT 1000H).
                        @;
                        @;AFTER WRITING OUT THE FILE (USING "FWRITE")
                        @;THIS SR REINITIALIZES THE POINTERS AND
                        @;INCREMENTS BYTE 8 OF THE FILENAME.  INTRRPTS
                        @;ARE DISABLED ON ENTERING THIS SR AND SHOULD
                        @;BE ENABLED AFTER RETURN IF NECESSARY.
                        @;
                        @;CLOCK FLAG IS CLEARED BEFORE RETURN.
                        @;ONLY THE IX AND IX REGISTERS
                        @;ARE PRESERVED.
                        @;
0487    F3              @DATWR:  DI              ;STOP INTERRUPTS
0488    2A 017F         @        LHLD   MBUFPT   ;CALCULATE #DATA PTS +3
048B    ED5B 017D       @        LDED   BFSTRT   ;
048F    1B              @        DCX    D        ;
0490    1B              @        DCX    D        ;
0491    1B              @        DCX    D        ;
0492    B7              @        ORA    A
0493    ED52            @        DSBC   D        ;
0495    E5              @        PUSH   H        ;SAVE FILE SIZE
0496    2B              @        DCX    H        ;CALCULATE #DATA PTS
0497    2B              @        DCX    H        ;
0498    2B              @        DCX    H        ;
0499    EB              @        XCHG            ;HL <= [BFSTRT] -3
                        @                        ;DE <= #DATA PTS
049A    3A 0137         @        LDA    CHNL     ;STORE #CHNL
049D    77              @        MOV    M,A      ;
049E    23              @        INX    H        ;
049F    72              @        MOV    M,D      ;STORE HIGH BYTE OF
04A0    23              @        INX    H        ;#DATA POINTS
04A1    73              @        MOV    M,E      ;STORE LOW BYTE OF
                        @                        ;#DATA POINTS
04A2    2B              @        DCX    H        ;
04A3    2B              @        DCX    H        ;
04A4    EB              @        XCHG            ;
04A5    E1              @        POP    H        ;HL <= #DATA PTS +3
                        @                        ;DE <= [BFSTRT] -3
                        @                        ;NOW CALCULATE #BLOCKS:
04A6    7D              @        MOV    A,L      ;
04A7    B7              @        ORA    A        ;
04A8    2801            @        JRZ    ..NOAD   ;
04AA    24              @        INR    H        ;
04AB    4C              @..NOAD: MOV    C,H      ;BC<=#BLOCKS
04AC    0600            @        MVI    B,0      ;
04AE    3E01            @        MVI    A,1      ;SPECIFY DISK #1
04B0    21 0185         @        LXI    H,FLNAME;HL<=ADDR OF FLNAME
                        @        ;
04B3    CD 04C5         @        CALL   FWRITE   ;WRITE DATA
                        @        ;
                        @        ;
04B6    21 018C         @        LXI    H,FLNAME+7 ;UPDATE
04B9    34              @        INR    M          ;FLNAME
04BA    2A 017D         @        LHLD   BFSTRT   ;UPDATE BUFFER PTR
04BD    22 017F         @        SHLD   MBUFPT   ;
04C0    3E50            @        MVI    A,50H    ;RESET CLOCK FLAG
04C2    D306            @        OUT    6        ;
04C4    C9              @        RET             ;RETURN
                        @;
```

Listing 1 continued:

```
                         .INSERT B:FWRITE
                @;************************************
                @;*                                  *
                @;*             FWRITE               *
                @;*                                  *
                @;************************************
                @;
                @;SUBROUTINE TO WRITE A FILE ONTO DISK
                @;UNIT #1 OR 2 USING DOS I/O ROUTINES.
                @;   EXPECTS:
                @;
                @;        A  = FILE DRIVE # (1 OR 2)
                @;        DE = STARTING RAM ADDR OF FILE
                @;        BC = # OF BLOCKS
                @;        HL = ADDR OF FILE NAME
                @
                @;FILENAME MUST CONSIST OF 8 ALPHANUMERIC
                @;CHARACTERS FOLLOWED BY A BLANK (ASCII 20).
                @;
                @;REGISTERS ARE NOT PRESERVED.
                @;
                @;SYMBOL TABLE:
                @;
201C            @DLOOK = 201CH   ;DOS FILE DIRECTORY LOOKUP
201F            @DWRIT = 201FH   ;DOS DIRECTORY ENTRY WRITE
2022            @DCOM  = 2022H   ;DOS DISK COMMAND SR
2028            @DOS   = 2028H   ;DOS ENTRY PT
                @;
04C5  D5        @FWRITE: PUSH    D         ;STARTING RAM ADDR
04C6  C5        @        PUSH    B         ;# BLOCKS
04C7  C5        @        PUSH    B         ;
04C8  E5        @        PUSH    H         ;FILE NAME ADDR
                @;
04C9  CD 201C   @        CALL    DLOOK
04CC  D2 050D   @        JNC     TAKEN     ;IF FILE NAME TAKEN
04CF  E5        @        PUSH    H         ;DISK ADDR
04D0  DDE1      @        POP     X         ;ONTO IX
04D2  21 050C   @        LXI     H,BLANK   ;BLANK FILENAME
04D5  CD 201C   @        CALL    DLOOK     ;BYTE 8 OF DOS ENTRY
                @                          ;RETURNED IN (HL)
04D8  DA 055F   @        JC      FULL      ;IF DISK FULL
                @;
                @;COPY FILE NAME, DISK ADDRESS AND #BLOCKS
                @;TO DIRECTORY ENTRY
                @;
04DB  01 FFF8   @        LXI     B,-8D     ;SUBTRACT 8
04DE  09        @        DAD     B         ;FROM HL
04DF  D1        @        POP     D         ;ADDR OF FILE NAME
04E0  EB        @        XCHG              ;* DE=ADDR OF DOS ENTRY
                @                          ;* HL=ADDR OF FILE NAME
04E1  01 0008   @        LXI     B,8D      ;PLACE 8 IN BC
04E4  EDB0      @        LDIR              ;COPY FILE NAME
04E6  EB        @        XCHG              ;HL=DOS ENTRY ADDR
04E7  DDE5      @        PUSH    X         ;COPY DISK ADDR
04E9  D1        @        POP     D
04EA  73        @        MOV     M,E
04EB  23        @        INX     H
04EC  72        @        MOV     M,D
04ED  23        @        INX     H
04EE  C1        @        POP     B         ;COPY # BLOCKS
04EF  71        @        MOV     M,C
04F0  23        @        INX     H
04F1  70        @        MOV     M,B
04F2  23        @        INX     H
04F3  3600      @        MVI     M,0       ;COPY FILE TYPE
04F5  23        @        INX     H
04F6  70        @        MOV     M,B       ;COPY TYPE DEP. INFO
04F7  23        @        INX     H
04F8  71        @        MOV     M,C
                @;
04F9  CD 201F   @        CALL    DWRIT     ;COPY ENTRY TO DISK
                @;
                @;SET UP REGISTERS FOR DCOM:
                @;
04FC  C1        @        POP     B         ;PUT # BLOCKS
04FD  79        @        MOV     A,C       ;INTO ACCUMULATOR
04FE  01 0001   @        LXI     B,1       ;COMMAND=WRITE
                @                          ;DISK UNIT = 1
0501  D1        @        POP     D         ;STARTING RAM ADDR
0502  DDE5      @        PUSH    X         ;MOVE DISK ADDR
0504  E1        @        POP     H         ;INTO HL
                @;
0505  CD 2022   @        CALL DCOM         ;WRITE FILE
0508  DA 0532   @        JC      ILLARG    ;CARRY SET=ILLEGAL ARG
050B  C9        @        RET
                @;
                @;
050C  20        @BLANK:  .ASCII  / /
                @;
050D  21 0516   @TAKEN:  LXI     H,..MESS;SEND MESSAGE TO CONSOLE
```

Listing 1 continued on page 420

Listing 1 continued:

```
0510      CD 047A        a          CALL     MESSOUT
0513      C3 2028        a          JMP      DOS
0516      46494C45204Ea..MESS:  .ASCIZ   /FILE NAME ALREADY TAKEN
052D      0D0A           a
052F      0D0A00         a/
                         a;
0532      21 053B        aILLARG: LXI      H,..MESS;SEND MESSAGE TO CONSOLE

0535      CD 047A        a          CALL     MESSOUT
0538      C3 2028        a          JMP      DOS
053B      494C4C454741a..MESS:  .ASCIZ   /ILLEGAL ARGUMENTS USED FOR DCOM

055A      0D0A           a
055C      0D0A00         a/
                         a;
055F      21 0568        aFULL:   LXI      H,..MESS;SEND MESSAGE TO CONSOLE

0562      CD 047A        a          CALL     MESSOUT
0565      C3 2028        a          JMP      DOS
0568      46494C452057a..MESS:  .ASCIZ   /FILE WRITE ABORTED; DISK FULL
0585      0D0A           a
0587      0D0A00         a/
0590                                .LOC     590H
                                    .INSERT  B:EVENTS
                         a;**********************************
                         a;*                                *
                         a;*        SPECIAL EVENTS          *
                         a;*                                *
                         a;**********************************
                         a;
                         a;
                         a;ENDEXP SR DISABLES INTERRUPTS, WRITES
                         a;DATA OUT TO DISK (BY CALLING DATWR),
                         a;UPDATES ENDFLG, AND JUMPS TO THE ADDR
                         a;PUT IN BY THE MAIN PROGRAM.
                         a;
0590      F3             aENDEXP: DI                ;KILL INTERRUPTS
0591      CD 0487        a          CALL     DATWR    ;WRITE DATA
0594      21 059B        a          LXI      H,ENDFLG;UPDATE FLAG
0597      35             a          DCR      M        ;
0598      C3 0598        aNXTEXP: JMP      NXTEXP   ;JMP TO MAIN
059B                     aENDFLG: .BLKB    1        ;END FLAG INITIALIZED
                         a                          ;BY MAIN PRGM
                         a;
                         a;
                         a;
                         a;* ** * ** * ** * ** * ** * ** * ** * ** *
                         a;
                         a;LITOFF:  THIS SR IS CALLED BY THE "PROCSR".
                         a;IT TURNS OFF THE LIGHT RELAY BY CLEARING
                         a;BIT 0 OF I/O PORT 24D AND RETURNS TO THE
                         a;PROCESSOR.
                         a;
059C      3E00           aLITOFF: MVI      A,0      ;
059E      D318           a          OUT      24D      ;
05A0      E1             a          POP      H        ;
05A1      C9             a          RET               ;
                         a;
                         a;
                         a;*  *  *  *  *  *  *  *  *  *  *  *  *  *  *
                         a;
                         a;LITON:   CALLED BY "PROCSR" TO TURN OFF LIGHTS
                         a;         BY CLEARING ALL BITS OF I/O PORT 24D
                         a;         AND THEN RETURNING TO THE PROCESSOR.
                         a;
05A2      3E01           aLITON:  MVI      A,1      ;
05A4      D318           a          OUT      24D      ;
05A6      E1             a          POP      H        ;
05A7      C9             a          RET               ;
                         a;
05B0                                .LOC     5B0H
                                    .INSERT  B:L/DEXP.ASM
                         a;**********************************
                         a;*                                *
                         a;*     LIGHT/DARK EXPERIMENT      *
                         a;*                                *
                         a;**********************************
                         a;
                         a;THESE TWO ROUTINES SET UP THE INTRPT
                         a;HANDLER AND PROCESSOR TO DO FIRST A
                         a;DARK EXPERIMENT AND THEN A LIGHT EXPT.
                         a;THE SAMPLING AND PROCESSING PARAMETERS
                         a;ARE ASSUMED TO HAVE BEEN PUT IN THE PROPER
                         a;LOCATIONS BY SOME PREVIOUS ROUTINE (IE
                         a;BASIC CALLS, OR OTHER).  FLNAME AND
                         a;ENDFLG ARE ALSO ASSUMED TO HAVE BEEN
                         a;INITIALIZED BY PREVIOUS ROUTINES.
                         a;THE LIGHT/DARK EXPERIMENTS CONTINUE
                         a;UNTIL ENDFLG IS CLEAR.  THE LIGHT RELAY
                         a;IS TURNED ON BY SETTING BIT 0 OF I/O PORT
```

Listing 1 continued:

```
                        @;30Q.
                        @;
05B0                    @SDATA:   .BLKB    3         ;STORE DARK SAMPLING
                        @                            ;PARAMETERS HERE
05B3                    @PDATA:   .BLKB    34D       ;STORE DARK PROCESSING
                        @                            ;PARAMETERS HERE
05D5                    @SLDATA:  .BLKB    3         ;STORE LIGHT SAMPLING
                        @                            ;PARAMETERS HERE
05D8                    @PLDATA:  .BLKB    34D       ;STORE LIGHT PROCSR
                        @                            ;PARAMETERS HERE
                        @                            ;
05FA    3A 059B         @DRKEXP:  LDA      ENDFLG    ;CHECK IF EXPT DONE
05FD    B7              @         ORA      A         ;
05FE    CA 065C         @         JZ       END       ;YES,END
0601    21 061F         @         LXI      H,LTEXP   ;NO,PUT JMP ADDR IN
0604    22 0599         @         SHLD     NXTEXP+1;  "ENDEXP"
0607    21 018B         @         LXI      H,FLNAME+6 ;PUT "D" SUFFIX
060A    3644            @         MVI      M,"D"     ; IN FILENAME
060C    11 05B3         @         LXI      D,PDATA   ;SET UP PROCSR
060F    CD 0468         @         CALL     P$INIT    ;
0612    11 05B0         @         LXI      D,SDATA   ;SET UP INTHDLR
0615    CD 0430         @         CALL     INIT      ;
0618    E1              @RETSEQ:  POP      H         ;RESTORE REGS
0619    E1              @         POP      H         ;
061A    C3 0352         @         JMP      RSTORE    ;
                        @;
                        @;
                        @;
061F                    @         .LOC     61FH
061F    3A 059B         @LTEXP:   LDA      ENDFLG    ;EXP DONE?
0622    B7              @         ORA      A
0623    CA 065C         @         JZ       END       ;YES, END
0626    21 05FA         @         LXI      H,DRKEXP  ;NO,PUT JMP ADDR
0629    22 0599         @         SHLD     NXTEXP+1 ; IN "ENDEXP"
062C    21 018B         @         LXI      H,FLNAME+6 ;PUT "L" SUFFIX
062F    364C            @         MVI      M,"L"     ; IN FILENAME
0631    11 05D8         @         LXI      D,PLDATA;SET UP PROCSR
0634    CD 0468         @         CALL     P$INIT    ;
                        @;
                        @;        NOW RESET TRANSDUCERS AND ADVANCE THE
                        @;        ADVANCE THE LIGHT FILTER MOTOR.
                        @;        PORT 24 ASSIGNMENT:  BIT 0 = LIGHTS
                        @;                                 1 = RESET DIFF
                        @;                                 2 = MOTOR ADV.
                        @;                                 7 = EXPT OFF
                        @;
0637    3E06            @STEPP:   MVI      A,6       ;SET BITS 1 & 2
0639    D318            @         OUT      24D       ;
063B    0E04            @         MVI      C,4       ;DO FOUR CYCLES OF
063D    CD 064C         @         CALL     WT50      ;50 MILLISEC WAIT
0640    3E00            @         MVI      A,0       ;CLEAR ALL BITS
0642    D318            @         OUT      24D       ;
0644    11 05D5         @         LXI      D,SLDATA;SET UP INTHDLR
0647    CD 0430         @         CALL     INIT
064A    18CC            @         JMPR     RETSEQ    ;RETURN TO STATUS
                        @;
                        @; *  *  *  *  *  *  *  *  *  *  *  *  *  *
                        @;
                        @;THIS ROUTINE WAITS 0.049999875 SEC TIMES THE
                        @;CONTENTS OF THE C-REGISTER.
                        @;REGISTERS C,D, AND E ARE ALTERED.  ALL OTHERS
                        @;ARE PRESERVED.
                        @;
064C    11 378E         @WT50:    LXI      D,378EH ;SEE PAGE 223 OF BUGBOOK
064F    1D              @..LOOP:  DCR      E         ;FOR EXPLANATION
0650    C2 064F         @         JNZ      ..LOOP    ;
0653    15              @         DCR      D         ;
0654    C2 064F         @         JNZ      ..LOOP    ;
0657    0D              @         DCR      C         ;
0658    C2 064C         @         JNZ      WT50      ;
065B    C9              @         RET                ;
                        @;
                        @; *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
                        @;
                        @;
                        @;
065C    21 0668         @END:     LXI      H,..MESS;SEND MESSAGE TO
065F    CD 047A         @         CALL MESSOUT       ;CONSOLE
0662    3E80            @         MVI      A,128D    ;SET BIT 7 OF
0664    D318            @         OUT      30Q       ;I/O PORT 30Q
0666    18B0            @         JMPR     RETSEQ    ;RETURN TO STATUS
0668                    @..MESS:  .ASCIZ   /
0668    0D0A2A2A2A20@*** EXPERIMENT COMPLETED ***
0686    0D0A            @
0688    0D0A00          @/
                        @;
                        @;
                        @;*  *  *  *  *  *  *  *  *  *  *  *  *  *  *
                        @;
                        @;THIS IS A BASIC CALL SUBROUTINE WHICH STARTS
                        @;EXPERIMENT WITH A DARK PERIOD.
```

Listing 1 continued on page 422

Listing 1 continued:

```
                    @;REGISTERS ARE NOT SAVED.
                    @;
068B    21 061F     @         LXI     H,LTEXP ;PUT JUMP ADDR INTO
068E    22 0599     @         SHLD    NXTEXP+1; "ENDEXP"
0691    21 018B     @         LXI     H,FLNAME+6; PUT "D" SUFFIX
0694    3644        @         MVI     M,"D"   ; INTO FILENAME
0696    11 05B3     @         LXI     D,PDATA ;SET UP PROCESSOR
0699    CD 0468     @         CALL    P$INIT  ;
069C    11 05B0     @         LXI     D,SDATA ;SET UP HANDLER
069F    CD 0430     @         CALL    INIT    ;START SAMPLING
06A2    C9          @         RET             ;RETURN
                    @;
                    @;        .INSERT B:HEADER.ASM
                    @;**********************************
                    @;*                                *
                    @;*           HEADER               *
                    @;*                                *
                    @;**********************************
                    @;
                    @;THIS SECTION RESERVES LOCATIONS AND
                    @;SETS UP THE HEADER MESSAGE.
                    @;
0700                @         .LOC    700H
                    @;
0700    202020202020@FLNM:    .ASCII  /
0708    0D0A        @/                        ;8 SPACES RESERVED FOR
                    @                         ;HEADER FILENAME
                    @;
070A    202020202020@DATE:    .ASCII  /
0715    0D0A        @/                        ;9 SPACES RESERVED FOR
                    @                         ;DATE
                    @;
0717    23204348414E@         .ASCII  /# CHANNELS:/
0722    202020      @HDCHNL:  .ASCII  /   /   ;STORE #CHNLS HERE
                    @                         ; (ASCII)
                    @;
                    @         .ASCII  /
0725    0D0A234C4947@#LIGHT,DARK EXPTS:/
0739    202020      @CYCLES:  .ASCII  /   /   ;STORE #CYCLES HERE
                    @;
                    @         .ASCII  /
073C    0D0A4441524B@DARK SAMPLING PARAMETERS:
0757    0D0A20202020@     SAMPLING RATE=/
076B    202020202020@DRATE:   .ASCII  /           /  ;STORE DARK
                    @                         ;SAMPLING RATE HERE
                    @;
                    @         .ASCII  $
0777    0D0A20202020@     #SAMPLES/DATA PT:$
078E    20202020    @DAVG:    .ASCII  /    /  ;STORE DARK S/DPT HERE
                    @;
                    @         .ASCII  /
0792    0D0A20202020@     TIME IN DARK:/
07A5    202020202020@DTIME:   .ASCII  /             /  ;STORE DARK TIME

                    @                                  ;HERE
                    @;
                    @         .ASCII  /
07B1    0D0A4C494748@LIGHT SAMPLING PARAMETERS:
07CD    0D0A20202020@     LIGHT PERIOD:/
07E0    202020202020@LTPER:   .ASCII  /             /  ;STORE LIGHT
                    @                                  ;PERIOD HERE
                    @;
                    @         .ASCII  /
07EC    0D0A20202020@     SAMPLING RATE:/
0800    202020202020@LRATE:   .ASCII  /             /  ;STORE LIGHT
                    @                                  ;SAMPLING
                    @                                  ;RATE HERE
                    @         .ASCII  $
080C    0D0A20202020@     #SAMPLES/DATA PT:$
0823    20202020    @LAVG:    .ASCII  /    /           ;STORE LIGHT
                    @                                  ;S/DPT HERE
                    @;
                    @         .ASCII  /
0827    0D0A20202020@     PERIOD OF LIGHT SAMPLING:/
0846    202020202020@LTIME:   .ASCII  /             /  ;STORE TIME
                    @                                  ;TO DO DARK
                    @                                  ;PROCESSING
                    @                                  ;HERE
                    @         .ASCII  /
0852    0D0A        @
0854    0D0A434F4D4D@COMMENTS:/
085F    2020202020  @COMNTS:  .ASCII  /     / ;PUT COMMENTS HERE
                    @;
                    @;
                    @;
                    @;THIS ROUTINE FILLS THE REGISTERS WITH THE
                    @;PROPER ARGUMENTS FOR WRITING THE HEADER
                    @;TO DISK.  IT THEN CHANGES THE FILE NAME
                    @;PREFIX TO "DF" (FOR DATA FILE) AND RETURNS.
                    @;
08E0                @         .LOC    8E0H
08E0    3E01        @HDWRIT:  MVI     A,1
```

Listing 1 continued:

```
08E2    11 0700      @          LXI     D,700H
08E5    01 0002      @          LXI     B,2
08E8    21 0185      @          LXI     H,FLNAME
08EB    CD 04C5      @          CALL    FWRITE
08EE    21 0185      @          LXI     H,FLNAME     ;CHANGE FILE NAME
                     @                               ;PREFIX
08F1    3644         @          MVI     M,"D"
08F3    23           @          INX     H
08F4    3646         @          MVI     M,"F"
08F6    C9           @          RET
                     @;
                     @;THIS ROUTINE OUTPUTS A MESSAGE LOCATED IN
                     @;RAM (DE) TO THE CONSOLE USING THE DOS
                     @;I/O ROUTINES AND THE D/A MESSOUT UTILITY.
                     @;
08F7    EB           @          XCHG                 ;HL<=DE
08F8    CD 047A      @          CALL     MESSOUT
08FB    C9           @          RET
                     @;
                     @;
                     @;THESE TWO ROUTINES (CALLABLE BY BASIC)
                     @;DISABLE AND ENABLE INTERRUPTS .
                     @;
08FC    F3           @          DI      ;
08FD    C9           @          RET     ;
                     @;
08FE    FB           @          EI      ;
08FF    C9           @          RET
0900                            .LOC    900H
                                .INSERT B:OGRAFX.ASM
                     @;************************************
                     @;****                            ****
                     @;****        OGRAFX              ****
                     @;****                            ****
                     @;************************************
                     @;
                     @;THIS ROUTINE OUTPUTS DATA FROM THE PROCESSOR
                     @;BUFFER TO AN OSCILLOSCOPE VIA A/D PORT 26.  IT
                     @;EXPECTS THE CALLING PROGRAM TO HAVE PLACED IN
                     @;'DSPCHL' THE CHNL MINUS ONE TO BE DISPLAYED.
                     @;
                     @;ON ENTERING, DE SHOULD CONTAIN THE # OF PTS TO
                     @;DISPLAY.  A TRIGGER PULSE IS SENT OUT PORT 25
                     @;TO MARK THE BEGINNING OF THE DISPLAY.
                     @;
                     @;ONLY THE IX AND IY REGS ARE PRESERVED.
                     @;
                     @;
                     @;IN DSPLY LOOP THE REGS ARE USED AS FOLLOWS:
                     @;
                     @;                 BC = # OF CHANNELS
                     @;                 DE = # OF DATA PTS
                     @;                 HL = ADDR OF DATA PTS
                     @;                  A = DATA
                     @;
0900                 @DSPCHL:   .BLKB   1           ;PUT CHNL-1 TO SAMPLE
0901    00           @          .BYTE   0           ;KEEP 0 FOR PROPER ADD
                     @;
0902    14           @OGRAFX:   INR     D           ;FOR PROPER COUNTING
0903    2A 017D      @          LHLD    BFSTRT      ;CALCULATE ADDR OF
                     @                              ;FIRST DATA PT
0906    ED4B 0900    @          LBCD    DSPCHL      ;
090A    B7           @          ORA     A           ;
090B    ED4A         @          DADC    B           ;
090D    3A 0137      @          LDA     CHNL        ;
0910    4F           @          MOV     C,A         ;PUT #CHNLS IN BC
0911    3E7F         @          MVI     A,127D      ;SEND TRIGGER PULSE
0913    D319         @          OUT     25D         ;
0915    3E00         @          MVI     A,0         ;
0917    D319         @          OUT     25D         ;
                     @;
0919    7E           @DSPLY:    MOV     A,M         ;DISPLAY DATA OUT 26
091A    D31A         @          OUT     26D         ;
091C    ED4A         @          DADC    B           ;INCR HL BY #CHNLS
091E    1D           @          DCR     E           ;DECREMENT POINTS CNTR
091F    20F8         @          JRNZ    DSPLY       ;
0921    15           @          DCR     D           ;
0922    20F5         @          JRNZ    DSPLY       ;
0924    20F3         @          JRNZ    DSPLY       ;LOOP TIL DONE
0926    C9           @          RET
                                .INSERT B:FREAD.ASM
                     @;****************************************
                     @;******                          ******
                     @;******        FREAD             ******
                     @;******                          ******
                     @;****************************************
                     @;
                     @;THIS SUBROUTINE READS A FILE FROM DISK TO
                     @;MEMORY USING THE NORTH STAR DOS ROUTINES.
                     @;
                     @;EXPECTS DE ON ENTERING TO BE A POINTER TO THE
                     @;RAM ADDR OF THE FILE NAME.  ALSO EXPECTS THE
```

Listing 1 continued on page 424

Listing 1 continued:

```
                        @;FOLLOWING PARAMETER TABLE TO BE PROPERLY
                        @;FILLED IN:
                        @;
0927     01             @DSKDVR: .BYTE    1         ;USE DRIVE #1
0928                    @FLADDR: .BLKW    1         ;STORE FILE PNTR HERE
                        @                           ;  (LOW/HIGH BYTES)
                        @;
                        @;
201C                    @DLOOK = 201CH              ;JMP ADDR FOR DLOOK
2022                    @DCOM  = 2022H              ;JMP ADDR FOR DCOM
2A04                    @BASIC = 2A04H              ;ENTER BASIC
                        @;
                        @;FOR CONVENIENCE THE FILENAME MAY BE PLACED
                        @;IN THE FOLLOWING BLOCK:
092A                    @        .BLKB    8         ;SAVE FOR FILENAME
0932     20             @        .BYTE    20H       ;ASCII BLANK
                        @;
                        @;ONLY IX,IY REGISTERS ARE PRESERVED.
                        @;
0933     EB             @FREAD:  XCHG               ;SET UP REGS FOR DLOOK
0934     3A 0927        @        LDA      DSKDVR    ;HL=PNTR TO FILENAME
                        @                           ;A =DISK UNIT #1
0937     CD 201C        @        CALL     DLOOK     ;
093A     3813           @        JRC      NOFILE    ;NO SUCH FILE, RETURN
                        @                           ;
093C     5E             @        MOV      E,M       ;SET UP REGS FOR DCOM
093D     23             @        INX      H         ;DE<=DISK ADDR
093E     56             @        MOV      D,M       ;
093F     23             @        INX      H         ;
0940     4F             @        MOV      C,A       ;C<=UNIT #1
0941     7E             @        MOV      A,M       ;A=# OF BLOCKS
0942     EB             @        XCHG               ;HL=DISK ADDR
0943     0601           @        MVI      B,1       ;B=READ COMMAND
0945     ED5B 0928      @        LDED     FLADDR    ;DE=FILE RAM ADDR
                        @;
0949     CD 2022        @        CALL     DCOM      ;
094C     381D           @        JRC      BOGUS     ;INVALID DCOM ARG
094E     C9             @        RET
                        @;
                        @;* * * * * * * * * * * * * * * * * * * * * *
                        @;
094F     21 0958        @NOFILE: LXI      H,..MESS;SEND MSSGE TO CRT
0952     CD 047A        @        CALL     MESSOUT ;
0955     C3 2A04        @        JMP      BASIC     ;
                        @;
0958                    @..MESS: .ASCIZ   /
0958     0D0A4E4F2053@NO SUCH FILE
0966     0D0A           @
0968     0D0A00         @/
                        @;
                        @;
096B     21 0974        @BOGUS:  LXI      H,..MESS;SEND MSSGE TO CRT
096E     CD 047A        @        CALL     MESSOUT ;
0971     C3 2A04        @        JMP      BASIC     ;
                        @;
0974                    @..MESS: .ASCIZ   /
0974     0D0A494C4C45@ILLEGAL DCOM ARGUMENTS
098C     0D0A           @
098E     0D0A00         @/
                        @;
                         ;
                                 .END

ADRDAT 01B2     BASIC  2A04     BEEP   035D
BFSTRT 017D     BLANK  050C     BOGUS  096B
CHNL   0137     CLK2FS 0248     COMNTS 085F
COUNT  0208     COUT   200D     CYCLES 0739
DATE   070A     DATWR  0487     DAVG   078E
DCOM   2022     DIVSR  013B     DLOOK  201C
DOS    2028     DRATE  076B     DRKEXP 05FA
DSKDVR 0927     DSPCHL 0900     DSPLY  0919
DTIME  07A5     DWRIT  201F     END    065C
ENDCK  0362     ENDEXP 0590     ENDFLG 059B
ESTART 036B     ETIME  013D     FETCH  01AA
FLADDR 0928     FLNAME 0185     FLNM   0700
FNXN   041F     FREAD  0933     FULL   055F
FWRITE 04C5     HDCHNL 0722     HDWRIT 08E0
HYDCR  0366     ILLARG 0532     INIT   0430
INTHLD 018E     INT$S  0138     LAVG   0823
LITOFF 059C     LITON  05A2     LRATE  0800
LTEXP  061F     LTIME  0846     LTPER  07E0
MBUFPT 017F     MESSOU 047A     NEXT   02F9
NOFILE 094F     NTMPAD 0183     NXTEXP 0598
N$EVTS 013C     OGRAFX 0902     OTMPAD 0181
OVFLAG 0247     OVFLOW 0372     PDATA  05B3
PLDATA 05D8     PROCSR 02DD     P$INIT 0468
RETSEQ 0618     RSTORE 0352     SAMPLE 019C
SCNTR  013A     SDATA  05B0     SLDATA 05D5
STDAT  01BB     STEPP  0637     STKPT  035B
S$DPT  0139     TAKEN  050D     TMPBF1 01C8
TMPBF2 01E8     TRANSF 02FF     UPDATE 0222
WT50   064C
```

Listing 2: *BASIC program that demonstrates how parameters may be passed to the data-acquisition program in listing 1 (referred to as UTIL in the BASIC program comments).*

```
100!"  ---  THIS PROGRAM DEMONSTRATES HOW BASIC CAN"
110!"  ---  PLACE SAMPLING PARAMETERS IN  'UTIL'"
120!\!"       'UTIL' SHOULD ALREADY BE LOADED" \!
130 INPUT"NAME OF DATA FILE (8 CHARACTERS, I.E. 'DATA.01A'):",N$
140 REM
150 !\!"      FILENAME IS NOW PUT IN ADDRESS 185 HEX"
160 M=389         \REM  = 185 HEX = 'FLNAME'
170 FOR I=1 TO 8
180   FILL M,ASC(N$(I,I))
190   M=M+1
200 NEXT I
210 !\!"THE SAMPLING INITIATOR REQUIRES A TABLE CONTAINING"
220 !"THESE PARAMETERS:"
230 !
240 !"       # CHANNELS TO SAMPLE;"
250 !"       # INTERRUPTS PER SAMPLE;"
260 !"       # SAMPLES PER DATA POINT;"
262 !
264 !" 'UTIL' SAMPLES CONSECUTIVE CHANNELS, STARTING AT"
266 !" PORT 25 (DECIMAL) OF THE A/D BOARD.  TRY 4 TO BEGIN WITH."
270 !\INPUT"HOW MANY CHANNELS TO SAMPLE?",C
280 FILL 0,C   \REM     START THE TABLE AT 0000
290 !
300 !" # INTERRUPTS PER SAMPLE TELLS 'UTIL' HOW OFTEN THE"
310 !" A/D BOARD SHOULD BE CALLED.  FOR EXAMPLE, SUPPOSE"
320 !" THE REAL TIME CLOCK ON THE MOTHERBOARD WAS SET FOR"
330 !" A 53.248 MILLISEC INTERVAL.  IF YOU WANTED TO"
340 !" SAMPLE ONCE A SECOND, THEN # INTERRUPTS PER SAMPLE"
350 !" SHOULD BE 19 (53.248*19= 1.01 SEC)."
360 !\INPUT"            # INTERRUPTS PER SAMPLE?",I1
370 FILL 1,I1
380 !
390 !" # SAMPLES PER DATA POINT TELLS 'UTIL' HOW MANY SAMPLES"
400 !" TO AVERAGE.  THE NUMBER SHOULD BE A NUMBER N, SUCH THAT"
410 !" N EQUALS TWO RAISED TO AN INTEGER POWER (I.E., 1,2,4,8,...)"
415 !" SO THAT 'FNXN' WILL WORK PROPERLY. TRY 1 TO BEGIN WITH."
420 !
430 INPUT"      # SAMPLES PER DATA POINT (POWER OF 2)?",N
440 IF N>256 THEN 430
450 FILL 2,N
460 !
470 P=0            \REM  CALCULATE PROCESS CODE
480 IF N=1 THEN 520
490 N=N/2
500 P=P+1
510 IF N>1 THEN 490
520 IF N<1 THEN 430
530 FILL 3,P          \REM  START TABLE AT 0003
540 !" NOW A PARAMATER TABLE MUST BE SET UP FOR 'P$INIT'."
550 !" THE FIRST PARAMETER IS THE PROCESS CODE FOR 'FNXN'."
560 !" THIS IS CALCULATED AS THE POWER OF TWO WHICH EQUALS N."
570 !
580 !" THE SECOND PARAMETER IS THE # OF PROGRAMMED EVENTS."
590 !" IN THIS EXAMPLE WE WILL HAVE ONLY TWO EVENTS.  THE"
600 !" FIRST WILL SET BIT 0 OF PARALLEL PORT 24 (30 OCTAL)"
610 !" AND THE SECOND WILL TERMINATE SAMPLING, WRITE THE"
620 !" BUFFER TO DISK AND SEND A MESSAGE TO THE CONSOLE."
630 !" OF COURSE, THE FIRST EVENT SHOULD BE SET FOR A TIME"
640 !" PRECEEDING THE SECOND EVENT.  THE PROGRAMS FOR THESE"
650 !" EVENTS CAN BE FOUND IN MODULES 'SPECIAL EVENTS' AND"
660 !" 'LIGHT/DARK EXPERIMENT'."
670 FILL 4,2
680 !
690 !" THE TIME REQUESTED IS CALCULATED AS THE NUMBER OF"
700 !" DATA POINTS ( = # INTERRRUPTS PER SAMPLE * # OF SAMPLES"
710 !" PER DATA POINT).  THUS IF # INTRRPTS/SAMPLE EQUALS 19"
720 !" AND # SAMPLES/DATA PT EQUALS 8, THEN THERE WILL BE 8"
730 !" SECONDS PER DATA POINT (ASSUMING 53 MS CLOCK) AND THE"
740 !" TIME FOR EACH EVENT HAS UNITS OF 8 SECONDS."
750 !
760 INPUT"        TIME FOR EVENT #1: ",T1
770 REM  PUT THE TIME IN THE TABLE, HIGH BYTE FIRST.
780 FILL 5,INT(T1/256)
790 FILL 6, T1 - INT(T1/256)*256
800 REM  NOW PUT THE ADDR OF EVENT PROGRAM #1 IN THE TABLE
810 REM
820 FILL 7,162      \REM LOW BYTE OF ADDR 5A2 HEX
830 FILL 8,5        \REM HIGH BYTE
840 REM
850 INPUT"        TIME FOR EVENT #2: ",T2
860 FILL 9,INT(T2/256)
870 FILL 10, T2 - INT(T2/256)*256
880 !
```

Listing 2 continued on page 426

Listing 2 continued:

```
890 REM  NOW PUT THE ADDR OF EVENT PROGRAM #2 IN THE TABLE
900 FILL 11,144     \REM LOW BYTE OF ADDR 590 HEX
910 FILL 12,5       \REM HIGH BYTE
920 REM
940 REM  'ENDEXP', THE ROUTINE THAT TERMINATES SAMPLING,
950 REM  REQUIRES THAT A JUMP ADDR BE FILLED IN. IT IS DONE
960 REM  BELOW
970 FILL 1433,92    \REM FILL 599 HEX WITH LOW BYTE OF ADDR 065C
980 FILL 1434,6     \REM FILL 59A HEX WITH HIGH BYTE OF ADDR
990 !
1000!" NOW THE PROCESSOR INITIALIZER IS CALLED."
1010 Q=CALL(1120,3)  \REM  3 = STARTING ADDR FOR PARAM. TABLE
1020 !
1030 INPUT"PRESS CARRIAGE RETURN TO START SAMPLING",Q$
1040 Q=CALL(1064,0)  \REM  0 = START OF PARAMETER TABLE
1050 !
1060 !"THIS BASIC PROGRAM IS ENDED, BUT SAMPLING WILL CONTINUE"
1065 !"UNTIL AN ENDING MESSAGE IS SENT TO THE CONSOLE."
1070 END
READY
```

Listing 3: *This program initializes the laboratory system for a sample biological experiment which will use all of the features of the lab system.*

```
1REM THIS PROGRAM INPUTS PARAMETERS FOR DOING A LIGHT/DARK
2REM EXPERIMENT.  IT PROMPTS THE USER FOR PARAMETERS, PLACES
3REM THEM IN THE L/DEXP PARAMETER STACKS AND WRITES A HEADER
4REM FILE DESCRIBING THESE PARAMETERS OUT TO DISK.
10 !TAB(20),"*** LIGHT/DARK EXPERIMENT ***"\!
20 !TAB(15),"A/D UTILITIES SHOULD ALREADY BE LOADED"\!
30 DIM C$(40)
40 K=53.248 \REM CLOCK INTRPT RATE IN MILLISEC
50 !\!"CLOCK INTERRUPT RATE= ",K," MSEC"
60 !"CHANGE LINE 40 IF DIFFERENT RATE"
100 REM FUNCTION CONVERTS A 4-DIGIT HEX NUMBER TO DECIMAL
105 DEF FNH(X$)
110 X=0
115 D=4096
120 FOR I=1 TO 4
125     T$=X$(I,I)
130     IF T$<="F" THEN 165
135     Y=VAL(T$)
140     Y=Y*D
145     D=D/16
150     X=X+Y
155     NEXT I
160 RETURN X
165 IF T$>="A" THEN 170 ELSE 135
170     Y=ASC(T$)
180     Y=Y-55
185     GOTO 140
190 FNEND
200 !"THESE ARE THE INPUTTED PARAMETERS:"\!\!
202 S1=FNH("03F7")
203 S2=FNH("0790")
205 C=CALL(S1,S2)
206 INPUT "PRESS CARRIAGE RETURN TO CONTINUE",K$
210 !\!"WHICH PARAMETERS DO YOU WANT TO ALTER?"
220 !TAB(8),"1=FILENAME/DATE"
225 !TAB(8),"2=# CHANNELS/# CYCLES"
230 !TAB(8),"3=DARK SAMPLING PARAMETERS"
235 !TAB(8),"4=LIGHT SAMPLING PARAMETERS"
240 !TAB(8),"5=COMMENTS"
245 !TAB(8),"6=ALL OF THE ABOVE"
247 !TAB(8),"7=NONE,BEGIN EXPERIMENT"
250 !\INPUT "WHICH NUMBER?",A
255 ON A GOTO 400,500,600,700,800,900,300
300 REM ************************************
305 REM
310 REM WAIT FOR CARRIAGE RETURN, THEN WRITE OUT HEADER,
315 REM START SAMPLING AND CHAIN "STATUS,2" WHICH
320 REM HAS STATUS ROUTINES.
325 !\!"MAKE SURE DATA DISK IS ON DRIVE #1"
330 !TAB(8),"STATUS DISK IS ON DRIVE #2"
335 !\INPUT"PRESS CARRIAGE RETURN TO START SAMPLING",K$
340 Q=FNH("08E0")          \REM  WRITE HEADER
350 Q=CALL(Q)
360 Q=FNH("068B")          \REM  START SAMPLING
370 Q=CALL(Q)
390 CHAIN "STATUS,2"   \REM STATUS ON DRIVE #2
395 REM
397 REM *  *  *  *  *  *  *  *  *  *  *  *  *
398 REM
400REM INPUT FILENAME/DATE AND RETURN
410 GOSUB 1000
```

Listing 3 continued:

```
420 GOTO 200
500REM INPUT #CHANNELS/#CYCLES AND RETURN
510 GOSUB 1300
520 GOTO 200
600REM INPUT DARK SAMPLING PARAMETERS
610 GOSUB 1500
620 GOTO 200
700REM INPUT LIGHT SAMPLING PARAMETERS
710 GOSUB 2300
720 GOTO 200
800REM INPUT NEW COMMENTS
810 GOSUB 3400
820 GOTO 200
900REM INPUT ALL NEW PARAMETERS
910 GOSUB 1000
920 GOSUB 1300
930 GOSUB 1500
940 GOSUB 2300
950 GOSUB 3400
960 GOTO 200
1000 REM PUT FILENAME INTO PROPER RAM LOCATIONS
1010 REM 0700=HEADER ADDR, 0135=UTILITY ADDR
1020 INPUT "TYPE FILENAME (IE HD000..A): ",C$
1030 H=FNH("0700")
1040 L=LEN(C$)
1050 IF L>8 THEN 1020
1060 GOSUB 9999
1070 H=FNH("0135")
1080 GOSUB 9999
1090REM PLACE DATE INTO HEADER
1100 INPUT "TYPE DATE: ",C$
1110 H=FNH("070A")
1120 L=LEN(C$)
1130 IF L>11 THEN 1100
1140 GOSUB 9999
1150 RETURN
1300REM PUT #CHANNELS INTO HEADER AND PARAMETER STACKS
1310 INPUT "NUMBER OF CHANNELS TO SAMPLE: ",C
1320 IF C>7  THEN 1310
1330REM N=POINTER FOR DARK PARAM STACK
1340REM M=POINTER FOR LIGHT PARAM STACK
1350 N=FNH("05B0")
1360 FILL N,C
1370 N=N+1
1380 M=FNH("05D5")
1390 FILL M,C
1400 M=M+1
1410 H=FNH("0722")
1420 GOSUB 9997
1430REM INPUT #CYCLES INTO HEADER AND ENDFLAG
1440 INPUT "TYPE # OF DARK,LIGHT PERIODS: ",C
1450 IF C>99 THEN 1440
1460 B=FNH("059B")
1470 FILL B,C
1480 H=FNH("0739")
1490 GOSUB 9997
1494 RETURN
1500REM PUT SAMPLING RATE INTO HEADER AND INT/S INTO STACK
1540 !\!"DARK SAMPLING PARAMETERS:"
1550 !TAB(8),"DESIRED SAMPLING RATE (IN SEC): ",
1560 INPUT C
1570 C1=INT(C*1000/K +.5)
1580 C=C1*K/1000
1590 N=FNH("05B1")
1600 FILL N,C1
1610 N=N+1
1620 !TAB(3),"ACTUAL SAMPLING RATE= ",C," SEC"
1630 H=FNH("076B")
1640 GOSUB 9997
1650 C1=C
1660 C$=" S"
1670 GOSUB 9998
1680REM PUT S/DPT INTO STACK AND HEADER
1690 !TAB(3),"SAMPLES PER DATA POINT (POWER OF 2): ",
1700 INPUT C
1710 IF C>128 THEN 1690
1720 FILL N,C
1730 N=N+1
1740 H=FNH("073E")
1750 GOSUB 9997
1760 C2=C
1770REM PUT PROCESSOR CODE INTO STACK
1780 P=0
1790 IF C=1 THEN 1830
1800 C=C/2
1810 P=P+1
```

Listing 3 continued on page 428

Listing 3 continued:

```
1820 IF C>1 THEN 1800
1830 FILL N,P
1840 N=N+1
1850 IF C<1 THEN 1690
1860REM PUT IN PROGRAMMED EVENTS
1870 FILL N,1
1880 N=N+1
1890 !TAB(8),"TIME IN DARK (X ,SEC/MIN/HR): ",
1900 INPUT C,K$
1910 C3=C1*C2
1920REM C1=SAMPLING RATE IN SEC, C2=#S/DPT
1930 IF K$="SEC"THEN 1980
1940 IF K$="MIN"THEN 1970
1950 IF K$="HR"THEN 1960 ELSE 1890
1960 C=C*60
1970 C=C*60
1980 C4=INT(C/C3+.5)
1990 C5=C3*C4
2000 IF K$="SEC" THEN 2030
2010 IF K$="MIN" THEN C5=C5/60
2020 IF K$="HR"THEN C5=C5/3600
2030 C6=0
2040 IF C4<256 THEN 2080
2050 C6=INT(C4/256)
2060 IF C6>255 THEN 1890
2070 C4=C4-C6*256
2080 FILL N,C6
2090 N=N+1
2100 FILL N,C4
2110 N=N+1
2120 !TAB(8),"ACTUAL TIME= ",C5," ",K$
2130 C=C5
2140 H=FNH("07A5")
2150 GOSUB 9997
2160 FILL N,FNH("0090")
2170 N=N+1
2180 FILL N,5
2190 N=N+1
2200 C$=" "+K$(1,1)
2210 GOSUB 9998
2220 RETURN
2300REM PUT LIGHT INT/S INTO STACK AND SAMPLING RATE IN HEADER
2310 !\!"LIGHT SAMPLING PARAMETERS:"
2320 !TAB(8),"DESIRED SAMPLING RATE (IN SEC): ",
2330 INPUT C
2340 C1=INT(C*1000/K +.5)
2350 C=C1*K/1000
2360 M=FNH("05D6")
2370 FILL M,C1
2380 M=M+1
2390 !TAB(8),"ACTUAL SAMPLING RATE= ",C," SEC"
2400 H=FNH("0800")
2410 GOSUB 9997
2420 C1=C
2430 C$=" S"
2440 GOSUB 9998
2450REM PUT S/DPT INTO STACK AND HEADER
2460 !TAB(8),"SAMPLES PER DATA POINT (POWER OF 2): ",
2470 INPUT C
2480 IF C>128 THEN 2460
2490 FILL M,C
2500 M=M+1
2510 H=FNH("0823")
2520 GOSUB 9997
2530 C2=C
2540REM PUT PROCESSOR CODE INTO STACK
2550 P=0
2560 IF C=1 THEN 2600
2570 C=C/2
2580 P=P+1
2590 IF C>1 THEN 2570
2600 FILL M,P
2610 M=M+1
2620 IF C<1 THEN 2460
2630REM PUT IN PROGRAMMED EVENTS
2640 FILL M,3       \REM 3 EVENTS
2650 M=M+1
2652 C3=C1*C2       \REM C3=SEC/DPT
2654REM C1=SAMPLING RATE IN SEC, C2=#S/DPT
2658 C4=INT(60/C3 + .5)    \REM CALCULATE 1-MIN
2660 FILL M,0
2662 M=M + 1
2664 FILL M,C4             \REM TURN ON LIGHT AFTER 1-MIN
2665 M=M+1
2666 FILL M,FNH("00A2")    \REM ADDR OF LITON
2667 M=M+1
2668 FILL M,5
2669 M=M+1
```

Listing 3 continued:

```
2680 !TAB(8),"LIGHT PERIOD (X ,SEC/MIN/HR): ",
2690 INPUT C,K$
2700 IF K$="SEC"THEN 2750
2710 IF K$="MIN"THEN 2740
2720 IF K$="HR"THEN 2730 ELSE 2660
2730 C=C*60
2740 C=C*60
2750 C4=INT(C/C3+.5) + C4
2760 C5=C3*C4
2770 IF K$="SEC" THEN 2800
2780 IF K$="MIN" THEN C5=C5/60
2790 IF K$="HR"THEN C5=C5/3600
2800 C6=0
2810 IF C4<256 THEN 2850
2820 C6=INT(C4/256)
2830 IF C6>255 THEN 2660
2840 C4=C4-C6*256
2850 FILL M,C6
2860 M=M+1
2870 FILL M,C4
2880 M=M+1
2890 FILL M,FNH("009C")
2900 M=M+1
2910 FILL M,5
2920 M=M+1
2930 C=C5-C3*INT(60/C3+.5)
2940 !TAB(8),"ACTUAL TIME= ",C," ",K$
2950 H=FNH("07E0")
2960 GOSUB 9997
2970 C$=" "+K$(1,1)
2980 GOSUB 9998
2990 !TAB(8),"PERIOD OF LIGHT SAMPLING (X,SEC/MIN/HR):",
3000 INPUT C,K$
3010 C3=C1*C2
3020REM C1=SAMPLING RATE IN SEC, C2=#S/DPT
3030 IF K$="SEC"THEN 3080
3040 IF K$="MIN"THEN 3070
3050 IF K$="HR"THEN 3060 ELSE 2990
3060 C=C*60
3070 C=C*60
3080 C4=INT(C/C3+.5)
3090 C5=C3*C4
3100 IF K$="SEC" THEN 3130
3110 IF K$="MIN" THEN C5=C5/60
3120 IF K$="HR"THEN C5=C5/3600
3130 C6=0
3140 IF C4<256 THEN 3180
3150 C6=INT(C4/256)
3160 IF C6>255 THEN 2990
3170 C4=C4-C6*256
3180 FILL M,C6
3190 M=M+1
3200 FILL M,C4
3210 M=M+1
3220 !TAB(8),"ACTUAL TIME= ",C5," ",K$
3230 C=C5
3240 H=FNH("0846")
3250 GOSUB 9997
3260 C$=" "+K$(1,1)
3270 GOSUB 9998
3280 FILL M,FNH("0090")
3290 M=M+1
3300 FILL M,5
3310 RETURN
3400REM INPUT COMMENTS
3410 !
3420 H=FNH("085F")
3430 INPUT "COMMENTS:",C$
3440 IF C$=""THEN 200
345 GOSUB 998
3460 C$=CH$(13)+CHR(10)
3470 GOSUB 9998
3480 IF H>=NH"ODF") THEN STOP
3490 GOTO 3430
3500 RETUR
9995REMSUBROUTINE TO PLACE STRING C$ OF LENGTH L
9996REM INTO MEMORY STARTING AT RAM H
                                             9997 C$=STR$(C)
9998 L=LEN($)
                  9999 FOR I=1 TO L
10000   T$=C$(I,I)
10001   FILL ,ASC($
102    H=H+1
10003    NEXT I
10004 RETURN
READY
```

Listing 4: *Program STATUS, which allows the operator to examine and control the progress of the sample experiment after running the program in listing 3. Both programs interact with the program in listing 1, which must be loaded into memory first.*

```
2 REM *********  STATUS  **********
4 REM
5 REM THIS PROGRAM FIRST WRITES OUT THE HEADER AND STARTS
6 REM THE EXPT, AND THEN PROMPTS FOR A CONTROL COMMAND
7 REM
21 REM
24 REM * * * * * * * * * * * * * * * * * * * * * *
27 REM
30 REM THIS SR CONVERTS A HEX NUMBER TO DECIMAL
33 DEF FNH(H$)
36 L=LEN(H$)
39 D=1
42 X=0
45 FOR I=2 TO L
48   D=D*16
51   NEXT I
54 FOR I=1 TO L
57   T$=H$(I,I)
60   IF T$<="F" THEN 81
63   Y=VAL(T$)
66   Y=Y*D
69   D=D/16
72   X=X+Y
75   NEXT I
78 RETURN X
81 IF T$>="A" THEN 84 ELSE 63
84   Y=ASC(T$) - 55
87   GOTO 66
89 FNEND
90 REM
91 REM * * * * * * * * * * * * * * * * * * * * * * *
92 REM
100 REM
110 REM * * * * * * * * * * * * * * * * * * *
120 REM
130 REM          THIS SECTION PROMPTS FOR A COMMAND
140 REM
142 !\!"CLOCK RATE = 53.248 MSEC; CHANGE LINE 7190 IF DIFFERENT"
144 !
150 !\!"EXPERIMENT IN PROGRESS - STATUS PROGRAM LOADED"
160 !\!"COMMANDS:"
170 !\!"     H = PRINT HEADER TO CONSOLE"
180 !  "     T = SHOW TIME INTO THIS CYCLE / # CYCLES LEFT"
190 !  "     A = ADVANCE TO NEXT CYCLE AFTER NEXT DATA PT"
200 !  "     E = END EXPT"
220 !  "     D = DISPLAY DATA IN BUFFER"
225 !  "     V = PRINT VOLTAGE LEVELS"
227 !  "     S = STOP INTERRUPTS"
229 !  "     R = RESTART INTERRUPTS"
230 !
240 INPUT"WHICH COMMAND?",C$
250 IF C$="H" THEN GOSUB  500
260 IF C$="T" THEN GOSUB 600
270 IF C$="A" THEN GOSUB 700
280 IF C$="E" THEN GOSUB 800
300 IF C$="D" THEN GOSUB 1000
305 IF C$="V" THEN GOSUB 4000
307 IF C$="S" THEN GOSUB 5000
309 IF C$="R" THEN GOSUB 6000
310 GOTO 150
480 REM
490 REM * * * * * * * * * * * * * * * * * * * * * * * *
495 REM
497 REM THIS SECTION CALLS AN ASSEMBLY ROUTINE
498 REM WHICH OUTPUTS THE HEADER VIA DOS I/O
499 REM
500 !
505 Q=CALL(2295,1792)
510 INPUT"PRESS CARRIAGE RETURN TO CONTINUE",Q$
550 RETURN
580 REM
585 REM * * * * * * * * * * * * * * * * * * * * * * * * *
587 REM
590 REM        THIS SECTION LOOKS INTO RAM TO FIND TIME THIS
593 REM        CYCLE HAS BEEN RUNNING AND # OF CYCLES LEFT
595 REM
600 GOSUB 7000
602 T$=" SEC"
604 T4=T1*T2*K1*B6
606 IF T4>120 THEN T$=" MIN"
608 IF T4>120 THEN T4=T4/60
609 !
```

Listing 4 continued:

```
610 !"THIS CYCLE HAS BEEN RUNNING FOR ",%6F2,T4,T$
620 E1=FNH("059B")      \REM ADDR OF ENDFLAG
630 E1=EXAM(E1)
640 !"# OF CYCLES LEFT = ",E1
650 RETURN
680 REM
685 REM * * * * * * * * * * * * * * * * * * * * * * * * * *
688 REM
690 REM       THIS SECTION ENDS THE CURRENT CYCLE AND
695 REM       ADVANCES TO THE NEXT CYCLE AFTER THE
697 REM       NEXT DATA POINT
699 REM
700 E2=FNH("08FC")
710 Q=CALL(E2)       \REM DISABLE INTERRUPTS
720 M=FNH("013C")    \REM ZERO EVENT TIME CNTR
725 FILL M,1
730 M=M+1
735 FILL M,0
740 M=M+1
742 FILL M,1
745 M=M+1
750 FILL M,FNH("0090")
752 M=M+1
755 FILL M,5
760 OUT 24,0           \REM TURN OFF ALL RELAYS
770 Q=CALL(E2+2)     \REM ENABLE INTERRUPTS
780 RETURN
785 REM
788 REM * * * * * * * * * * * * * * * * * * * * * * * * *
789 REM
790 REM          THIS SECTION ENDS THE EXPT BY PUTTING A ONE
792 REM          IN ENDFLAG AND THEN ENDING THE CURRENT CYCLE
795 REM
800 M=FNH("059B")
820 FILL M,1
840 GOSUB 700      \REM END CYCLE
860 RETURN
960 REM
970 REM * * * * * * * * * * * * * * * * * * * * * * * * *
980 REM * * * * * *    DISPLAY     * * * * * * * * * *
990 REM * * * * * * * * * * * * * * * * * * * * * * * * *
1000!\!"THIS PROGRAM GRAPHICALLY DISPLAYS DATA"
1010!"CONTAINED IN THE A/D UTILITIES BUFFER"
1020!
1030 GOSUB 7000      \REM FETCH CONSTANTS FROM RAM
1040 !
1050 ! "THERE ARE ",C1," CHANNELS WITH ",B6," POINTS EACH IN THE BUFFER"
1060 !\INPUT "WHICH CHANNEL DO YOU WANT DISPLAYED?",C2
1070 IF C2<1 THEN STOP
1080 IF C2 > C1 THEN 1060
1090 !\INPUT"DISPLAY TYPE? (C=CRT; O=OSCOPE; S=STRIP CHART):",D1$
1100 IF D1$="C" THEN 1500
1110 IF D1$="O" THEN 2000
1120 IF D1$="S" THEN 3000
1130 GOTO 1090
1140 REM
1470 REM
1475 REM * * * * * * * * * * * * * * * * * * * * * * * *
1480 REM
1485 REM THE FOLLOWING SECTION OUTPUTS THE DATA BUFFER
1490 REM GRAPHICALLY ONTO THE SOROC 120 CRT
1495 REM
1500 FOR I=1 TO 24
1505 ! \NEXT I          \REM CLEAR CRT
1510 REM
1515 REM
1520                        REM PUT TIME SCALE ON SCREEN
1525 OUT 2,27             \REM LOAD CURSOR
1530 OUT 2,61
1535 OUT 2,54
1540 OUT 2,32
1545 T3=A1*T1*T2*K1     \REM TIME PER DATA PT
1550 T$=" SEC"
1555 IF T3>=120 THEN T$=" MIN"
1560 IF T3>=120 THEN T3=T3/60
1565 !"EACH POINT = ",%5F1,T3,T$
1570 REM
1575 REM
1580 REM INITIALIZE X, AND DATA ADDR'S
1585 D1=B1 + C2 - 1         \REM ADDR OF DATA
1590 X=32                   \REM CURSOR X-POSITION
1615 Y=0                   \REM LOOP TILL DISPLAY DONE
1620 FOR I=1 TO A1
1625   Y=Y + EXAM(D1)       \REM AVERAGE PTS
1630   D1=D1+C1
1635   NEXT I
```

Listing 4 continued on page 432

Listing 4 continued:

```
1640 Y= INT(Y/A1 + .5)
1645 REM CONVERT TO 0-255 SCALE
1650 IF Y<128 THEN Y1=Y+128
1655 IF Y>127 THEN Y1= ABS(128-Y)
1660 Y=INT(Y1/10)
1665 IF Y>23 THEN Y=23     \REM SCALE TO 0-23 FOR CURSOR LOADING
1670 Y= ABS(23-Y) + 32     \REM Y-POSITION CODE
1675 OUT 2,27              \REM LOAD CURSOR AND OUTPUT CHAR
1680 OUT 2,61
1685 OUT 2,Y
1690 OUT 2,X
1695 OUT 2,C2+48
1700 X=X+1                 \REM UPDATE X
1705 IF X=112 THEN 1735
1710 IF X<B7+32 THEN 1615
1725 REM DISPLAY DONE, PROMPT FOR NEXT CHNL TO DISPLAY
1730 REM
1735 OUT 2,27              \REMLOAD CURSOR
1740 OUT 2,61
1745 OUT 2,55
1750 OUT 2,32
1755 INPUT1"CHANNEL TO DISPLAY (0=END)?",C2
1760 IF C2=0 THEN 150
1765 IF C2>C1 THEN 1755
1770 GOTO 1580
1775 REM
1990 REM
1995 REM * * * * * * * * * * * * * * * * * * * * * * * *
1996 REM
1997 REM THE FOLLOWING SECTION OUTPUTS THE DATA BUFFER
1998 REM TO THE OSCOPE VIA D/A PORT 26 WITH THE TRIGGER
1999 REM PULSE COMING OUT PORT 25
2000REM
2100 P1=FNH("0900")      \REM  ADDR TO PUT CHNL CODE
2120 C3=C2-1             \REM  CHNL CODE
2140 FILL P1,C3
2145 T$=" SEC"          \REM CALCULATE TIME SCALE
2150 T4=K1*B6*T1*T2
2155 IF T4>=120 THEN T$=" MIN"
2160 IF T4>=120 THEN T4=T4/60
2170 !\!"CHANGE ANY BIT OF PORT 24 FOR NEW CHANNEL"
2175 !\!"TOTAL OUTPUT = ",%6F1,T4,T$
2177 P9=INP(24)
2180 Q=CALL(P1+2,B6)     \REM OUTPUT BUFFER
2190 IF INP(24)=P9 THEN 2180 ELSE 2200
2200 INPUT"WHICH CHANNEL DO YOU WANT TO DISPLAY?(0=END):",C2
2220 IF C2<1 THEN 150
2230 GOSUB 7000
2240 IF C2>C1 THEN 2200
2260 GOTO 2100
2990 REM
2995 REM * * * * * * * * * * * * * * * * * * * * * * * * *
2997 REM
2998 REM THIS ROUTINE OUTPUTS THE DATA BUFFER
2999 REM VIA PORT 26 TO THE STRIP CHART RECORDER
3000 T$=" SEC"          \REM CALCULATE TIME SCALE
3010 T4=K1*B6*T1*T2
3020 IF T4>=120 THEN T$=" MIN"
3030 IF T4>=120 THEN T4=T4/60
3040 !"TOTAL OUTPUT = ",%6F1,T4,T$
3050 !\INPUT "PRESS CARRIAGE RETURN TO START OUTPUT",Q$
3060 !\!"CHANNEL ",C2," BEING OUTPUT",
3070 REM
3080 D1=B1 + C2 - 1     \REM INITIALIZE DATA PT ADDR
3090 REM
3100 FOR I=1 TO 10      \REM OUTPUT STARTING POINTS
3110     OUT 26,128
3120     GOSUB 3000      \REM DELAY SR
3130     NEXT I
3140 REM
3150 REM           OUTPUT BUFFER TILL DONE
3160 FOR I=1 TO B6
3170     Y=EXAM(D1)
3180     OUT 26,Y
3190     D1=D1 + C1
3200     GOSUB 3000
3210     NEXT I
3220 REM
3230 REM             OUTPUT ENDING POINTS
3240 FOR I=1 TO 10
3250     OUT 26,128
3260     GOSUB 3000
3270     NEXT I
3280 REM
3290 REM            \!\!\!"DISPLAY FINISHED"
3300 !
```

Listing 4 continued:

```
3310 INPUT"WHICH CHANNEL DO YOU WANT TO DISPLAY?(0=END)",C2
3320 IF C2<1 THEN 150
3330 IF C2>C1 THEN 3310
3340 GOTO 3040
4000 REM
4020 REM    ***  THIS SECTION PRINTS THE VOLTAGE
4040 REM    ***  OUTPUTS FOR EACH DIFF. CHANNEL
4060 REM
4080 DO= -2.00            \REM DIFF OFFSET
4100 !"DIFFERENTIATOR OFFSET = ",DO," VOLTS"
4120 C1=FNH("0137")
4140 C1=EXAM(C1)          \REM # CHNLS
4160 FOR I=1 TO C1
4180     VO=INP(24+I)
4200     IF VO<128 THEN V1=VO+128  \REM SCALE 0-255
4220     IF VO>127 THEN V1=ABS(128-VO)
4240     V1=(V1*.02) -2.56
4260     !"CHANNEL ",I," = ",V1," VOLTS"
4280 NEXT I
4300 RETURN
5000REM         ***
5010REM         ***     SR TO DISABLE INTERRUPTS
5020REM         ***
5030 Q=FNH("08FC")
5040 Q=CALL(Q)
5050 RETURN
6000REM         ***
6010REM         ***     SR TO RESTART INTERRUPTS
6020REM         ***
6030 Q=FNH("08FE")
6040 Q=CALL(Q)
6050 RETURN
7000 REM * * * * * * * * * * * * * * * * * * * * * * * * *
7010 REM
7020 REM THIS SECTION FETCHES CONSTANTS FROM RAM
7030 REM
7040 B1=FNH("1000")     \REM  BUFSTRT
7050 B2=FNH("017F")     \REM  CONVERT MBUFPT TO DECIMAL
7060 B3=B2+1
7070 B2=EXAM(B2)
7080 B3=EXAM(B3)*256
7090 B4=B3 + B2
7100 B5=B4 - B1          \REM #PTS IN BUF
7110 REM
7120 C1=FNH("0137")
7130 C1=EXAM(C1)         \REM # CHNLS
7140 REM
7150 B6=B5/C1            \REM #PTS/CHNL
7160 A1=INT(B6/80 + .3)  \REM # PTS TO AVE FOR DISPLAY
7170 IF A1=0 THEN A1=1
7180 B7=INT(B6/A1)
7190 K1=.053248        \REM CLOCK INTERRUPT RATE
7200 T1=FNH("0138")
7210 T2=T1 + 1
7220 T1=EXAM(T1)         \REM #INT/SAMPLE
7230 T2=EXAM(T2)        \REM # SAMPLES/DATA PT
7240 RETURN
7900 REM
7910 REM  * * * *   DELAY BETWEEN DATA OUTPUT   * * * *
7920 REM
8000 FOR J=1 TO 20 \NEXT J
8100 RETURN
9000 END
READY
```

Five Spelling-Correction Programs for CP/M-Based Systems

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When I had trouble with an applications program last year, I appealed to my software vendor for help. He wrote me, "I have been in touch with the publisher, but I am getting noware fast." Noware, of course, was the leading technology before the invention of hardware, software, and firmware. Was noware making a comeback? No way. "Noware" was a spelling error. And the only way for a poor speller to discover errors like this was with software. But no proofreading software was then available for microcomputers.

At a Glance

Name
The Word

Author
Wayne Holder

Type
Proofreader for spelling errors, including 45,000-word literal dictionary, as well as programs to look up words in a dictionary on disk, count words, report on word frequency, search dictionary for words matching letter patterns, and sort words in a file into an alphabetical list with all redundancy eliminated

Manufacturer
Oasis Systems
2765 Reynard Way
San Diego CA 92103
(714) 291-9489

Price
$75

System Requirements
CP/M 1.4 or 2.2 operating system, CDOS, or IMDOS; 8080/85 or Z80 CPU with 32 K bytes of memory; one or two disk drives; keyboard input and hardcopy output; CP/M-compatible word processor, including WordStar, WordMaster, Ed, and Magic Wand

Format
CP/M single-density 8-inch disk

Language
8080 machine language

Documentation
30 pages, soft cover, stapled

Audience
Anyone with a CP/M-compatible word-processing system, especially writers and editors

Until recently, I didn't think the time had come for a good proofreading program running on microcomputers. Fortunately, I was wrong. Help has now arrived for the small-computer owner who can't spell or can't find misspellings. Not counting programs designed for use with only a single word-processing program, at least five proofreading programs are now available for CP/M-based computers: Microproof, The Word, Spellguard, Microspell, and Wordsearch. After using them for several weeks, I'm convinced that four have real merit. The four useful programs share some virtues, but each program also has features that appeal to a particular group of users.

You might base your choice among the four programs on the characteristics of your hardware—particularly the disk capacity. Or your word-processing software might mesh well with one of the programs, depending, for example, on whether your text editor will let you run a proofreading program from inside (ie: as a pseudocommand in the editor). Then again, each program has its own way of letting the user deal with a text file. Would you prefer a program that quickly checks a file and prints a list of suspect words? Or would you rather have the program present the suspect words to you one by one, so you can see if the word is really misspelled? Or how about a program that lets you see each word's context and change the original text? Another important criterion is price, and the range is great.

I'll discuss each of the five programs in turn, including their performance in benchmark tests. But first I'll state the opinions I've formed about what a proofreading program must do to be useful. Also, I'll explain how I tried to devise benchmarks that are meaningful for five programs, all of which work differently.

What a Proofreading Program Must Do

If you told someone it was okay to bring a few friends to your party, how would you feel if 500 strangers appeared? You'd feel the same way about a proofreading program that found fifty suspect words for every one that was actually misspelled. A proofreading program that finds all the misspelled words in a document is of little use if the program also finds hundreds of correctly spelled words suspect. How can the list of suspect words be kept manageable? It requires an extensive dictionary; I think 20,000 words is the minimum. The words must be correct and well chosen.

Another feature that keeps down the number of correct words mistaken for misspellings is the ability to create special dictionaries for your particular interests. Proofreading programs can also recognize more words by breaking words into roots, prefixes, and suffixes before checking the dictionary. But that has its drawbacks, because you can't stick any suffix or prefix on any root and get a real word.

A proofreading program should also provide a handy way to dispose of suspect words that are in fact correct. If a program presents the suspect words in one list, you need a quick way to delete correct words from the list. If a program presents suspects one at a time, you should be able to accept or reject each word with a single keystroke.

Equally important, the program must facilitate correction of misspelled words. One way is to mark suspect words in the original text file with a character that's easy to find later by using a text editor's search command. In

At a Glance

Name
Spellguard

Author
Denis Coleman

Type
Proofreader for spelling errors, including 20,000-word literal dictionary

Manufacturer
Innovative Software Applications
POB 2797
Menlo Park CA 94025
(415) 326-0805

Price
$295

System Requirements
CP/M 1.4, 2.0, or later operating system, or CDOS; 8080/85 or Z80 CPU with 32 K bytes of memory; one or two disk drives; keyboard input and hard-copy output; CP/M-compatible word processor, such as WordStar, Word-Master, Magic Wand, Electric Pencil, or Ed

Format
CP/M single-density 8-inch disk; North Star double-density 5-inch disk; or SuperBrain 5-inch CP/M disk

Language
8080 machine language

Documentation
116 pages in three-ring binder

Audience
Anyone with a CP/M-compatible word-processing system

At a Glance

Name
Wordsearch

Type
Proofreader for spelling errors, including 7200-word literal dictionary, with routines to list misspelled words and display the text file with misspellings highlighted

Manufacturer
Keybits Incorporated
POB 592293
Miami FL 33159
(415) 524-8098

Price
$195

System Requirements
CP/M-compatible operating system; 8080 or Z80 CPU with 32 K bytes of memory; dual 8-inch single-density disk drives; 24 by 80 video terminal; CP/M-compatible word processor

Format
CP/M single-density 8-inch disk

Language
8080 machine language

Documentation
46 pages in three-ring binder

Audience
Anyone with a CP/M word-processing system

that case, the mark should be easy to delete during editing. And the mark should be made in a disk file, not on paper. Working from paper is too slow.

Another way for a proofreading program to facilitate correcting misspelled words is to provide a means to replace the word in the original file. With some word processors, however, this approach runs the risk of disturbing the format of the original text—especially in justified copy.

No matter what its other virtues, a proofreading program must also work quickly. Most significant among the factors affecting the speed of operation is the size of the dictionary. Putting too many little-used words in the dictionary may sacrifice speed in proofreading without reducing the number of suspect words. Putting too few words in the dictionary results in long lists of suspect words, and that also wastes time. The dictionary must strike a balance.

Benchmarks

Originally, I thought I could just run each program until it finished and note how long it took. But no two programs finished in the same place. Spellguard proofreads the file, lets you judge each suspect word, and then Spellguard itself marks the words indicated. The Word proofreads the file, gives you a list of suspect words, and lets you trim the list with your own text editor; you can mark the confirmed misspellings by running The Word's

At a Glance

Name
Microspell

Author
Bob Lucas

Type
Proofreader for spelling errors, including 26,000-word literal dictionary and suffix-stem logic to encompass a wider vocabulary, with integral routines to display the context of a misspelled word, guess the word intended, look up words in the dictionary, count words, search dictionary for words matching letter patterns, and correct the misspelling in the original text file

Manufacturer
Lifeboat Associates
1651 Third Ave
New York NY 10028
(212) 860-0300

Price
$249

System Requirements
CP/M 1.4 or 2.2 operating system; 8080 or Z80 CPU with 48 K bytes of memory; one disk drive with at least 150 K bytes; keyboard input and hard-copy output; CP/M-compatible word processor

Format
Great variety of CP/M disk formats

Language
8080 machine language

Documentation
30 pages, soft cover, stapled

Audience
Anyone with a CP/M-compatible word-processing system

At a Glance

Name
Microproof

Author
Phillip Manfield

Type
Proofreader for spelling errors, including 50,000-word dictionary (counting words constructed from roots, prefixes, and suffixes), with optional routines to display the context of a misspelled word and correct the misspelling in the original text file

Manufacturer
Cornucopia Software
POB 5028
Walnut Creek CA 94596
(415) 524-8098

Price
$169 standard version; $60 for correcting option

System Requirements
CP/M 1.4 or 2.2 operating system or TRSDOS for Model I, II, or III TRS-80; Z80 CPU with 32 K bytes of memory; one 5-inch or 8-inch disk drive; keyboard input and hard-copy output; word processor

Format
CP/M 8-inch single-density; TRS-80 Model I, II, or III

Language
Z80 machine language

Documentation
24 pages, no cover, stapled

Audience
Anyone with a CP/M or TRS-80 word-processing system

MARK program from inside your text editor. Microspell and Microproof let you review each word, but there's no need to mark bad words because these two programs make corrections directly in the text file. Since Wordsearch neither marks suspect words in the text file nor corrects errors itself, you have to work from paper.

For a quick comparison and summary of the differences between the programs, see tables 1 and 2.

How Long Until When?

It was easy to compare how long the programs take to check the words in a document against the dictionary and then list all the suspect words. But that comparison didn't really measure how the programs perform in normal use. Since Spellguard and The Word both mark words in the text file, I wanted to compare how long they take to proofread a file and mark the suspects. But you have to

	Words	Bytes	Files	Common Proper Names	Common Place Names	User Add Words	User Make Special Dictionaries
Microproof	50,000*	72 K	3	No	No	Yes	Yes
Microspell	26,000**	154 K	4	Yes	Yes	Yes	Yes
Spellguard	20,000	170 K	1	No	No	Yes	Yes
The Word	45,000	160 K	1	Yes	Yes	Yes	Yes
Wordsearch	7200	72 K	2	No	No	Yes	Yes

* This is not a literal dictionary. The figure 50,000 includes all the words that can be formed by adding suffixes and prefixes to roots; therefore, some "words" included in the count are not true English words.

** Incorporating all the ED.VOC vocabulary file and three-fourths of the ING.VOC vocabulary file into the four-file main dictionary. Both VOC files are supplied with the program and can be added to the main dictionary if disk space permits. Though Microspell claims only a 26,000-word dictionary, its suffix-and-root functions help the program recognize about the same number of words as a 45,000-word literal dictionary.

Table 1: *Comparison of the dictionaries of the five proofreading programs. Dictionaries for Spellguard, The Word, and Wordsearch are literal. Microspell has a 20,000-word literal dictionary, but provides more words in the files ING.VOC and ED.VOC, most of which were added to the original dictionary. Microspell's dictionary uses suffix-root routines to extend its coverage to a range somewhat broader than Microproof's dictionary. Although the Microproof dictionary claims contents of 50,000 words, that includes many nonwords formed by adding prefixes and suffixes to roots.*

run your text editor before The Word marks the file, and it seemed unfair to charge The Word for the time needed to load the text editor. After all, with The Word, the text editor is already loaded when you finish marking the file, so you can make corrections almost immediately. With Spellguard, you still have to load the text editor to make corrections; it's just that you load the editor *after* marking the errors.

To complicate matters, fairness to Microspell and Microproof—the direct-correction programs—requires seeing how long it takes to run the other proofreading programs *plus* exiting those programs and loading your own text editor to make corrections *plus* saving the corrected file. On the other hand, is it fair to hold those other programs responsible for the time it takes me to run an elaborate word processor like WordStar? Would *it* be fairer to use a smaller editor?

Right or wrong, here's what I decided to do: I've given the time each program needs to scan a text file and list all the suspect words; I've given the time the marking programs need to scan the text file, review the suspects, mark the text file, plus the time needed to load the text editor and call up the text file for editing (that seems fair to Spellguard and The Word); I've given the time each program needs to do all the above, plus making corrections and saving the corrected file (to be fair to Microproof and Microspell).

What Is a Suspect Word?

I decided to count as a suspect word both every word

	Mark Word	Correct Word	Guess Word	Find Similar Words	Display Context	Count Word Frequency
Microproof	No	Yes*	No	No	Yes*	No
Microspell	No	Yes	Yes	Yes	Yes	No
Spellguard	Yes	No	No	No	No	No
The Word	Yes	No	Yes	Yes	No	Yes
Wordsearch	No	No	No	No	Yes	No

* Requires the correcting option.

Table 2: *A summary of the features of the five proofreading programs. Sometimes the same feature is implemented differently in different programs.*

and word *fragment* listed by the proofreading program. For programs that treat hyphens as spaces, I counted the fragments "accom" and "plished" as two suspect words. My rationale is that the fragments usually appear alphabetically and I have to consider each fragment and determine whether it is a misspelled word or not. Word fragments take the same amount of work as words.

This concludes the discourse on method. I tested the programs on a 400-word file (figure 1) and a 3000-word file. The results are shown in tables 3 and 4.

Spellguard Version 1.0

Spellguard is a magnificent program of the highest commercial quality. If your main concerns are speed and accuracy in straightforward proofreading, and if you have plenty of disk space, Spellguard is probably for you. Spellguard is menu-driven and the screen tells you all you need to know. The program lets you make every decision with a single keystroke.

The Package—In addition to its dictionary (170 K bytes), Spellguard includes the programs SP.COM (6 K bytes), SP.ISA (38 K bytes), and MAINTAIN (14 K bytes). SP.COM, SP.ISA, and the dictionary must all be present for Spellguard to operate (though the dictionary can be on a different disk drive). MAINTAIN is needed only when you wish to verify that Spellguard is working properly. ISA (Innovative Software Applications) also offers a limited dictionary for systems with low-capacity disks, and will soon offer dictionaries both more compact and more comprehensive, as described below.

Dictionary—As of this writing, Spellguard's dictionary contains approximately 20,000 words and takes up 170 K bytes of disk space. Spellguard's dictionary is literal; the program never assembles words from roots and suffixes. Denis Coleman, Spellguard's author, started work on it after writing a book in which he misspelled his own name. Coleman also saw the need for proofreading papers he wrote as a management consultant.

Coleman based the dictionary on two sources: Kucera's word-frequency study of 1962 and the *American Heritage Word Frequency Book* (Boston: Houghton Mifflin Company, 1971). It also includes words drawn from Coleman's own documents and papers of Spellguard users.

ISA will soon offer a version of its standard 20,000-word dictionary compressed to 32 percent of its present size, about 55 K bytes. In addition, it plans three additional dictionaries: a 30,000- to 40,000-word general dictionary, a 15,000-word medical dictionary, and a 15,000-word legal dictionary. Data compression will be standard in all of them. According to Coleman, ISA's techniques of data compression will result in increased operating speed for Spellguard.

Performance—Though Spellguard needed only 56 seconds to proofread the file shown in figure 1 and

	Misspelled Words in File	Words Found Suspect	Words Wrongly Found Suspect	True Mis-spellings Found	Misspelled Words Missed	Time to Proofread File	Time Until Ready to Correct	Time Until All Corrections
Microproof	7	32	26	6	1	0:45		2:16**
Microspell	7	26	20	6	1	1:06*		2:47**
Spellguard	7	47	40	7	0	0:56•	2:31••	3:40
The Word	7	19	12	7	0	1:39'	3:15''	4:00
Wordsearch	7	105	98	7	0	0:55°	4:56°°	6:13°°°

* Using the switches that suppress display of context and creation of an output file of suspect words.

** Microproof and Microspell do not require a text editor to make corrections. However, since both programs accepted an incorrect word in this file, correcting that word required running the text editor and saving the file. When Microspell or Microproof misses a word, about 1:20 must be added to the timing shown.

• Skipping the regular word review, going to the special word review, and asking that all suspect words be listed at once (Option L on Special Word Review Menu).

•• Time to proofread, review suspect words one by one, mark legitimate errors, load WordStar, and call up text file to start making corrections.

' Time to proofread and list suspect words found.

'' Time to proofread, load WordStar, use WordStar to edit list of suspect words, save shortened file of suspect words, run The Word's MARK program while still inside WordStar, and call up marked text file to make corrections.

° Running the Scan function followed by the List function.

°° Time to proofread file, assign words to one of three groups, print a list of confirmed misspellings, load WordStar, and call up unmarked text file. Wordsearch neither marks errors nor corrects.

°°° Since Wordsearch doesn't mark errors, each misspelled word had to be typed in as a search string, and that added to the time required to make corrections.

Table 3: *Performance of the proofreading programs on the 400-word text file in figure 1. The first timing shows how long each program takes to read the file and list all suspect words. The second timing shows how long each program takes to read the file, find the suspect words, decide which suspects should be marked, mark the suspects, and call up the text file to make corrections. Microproof and Microspell have no timing in this column because they make corrections in the original text file. The third timing shows how long it takes to read the file, find the suspect words, decide which suspects should be marked or corrected, make the corrections (in some cases directly, in other cases using a word processor), and save the file. In cases where Microspell or Microproof failed to recognize a misspelled word, the user must load a word processor and make the correction. That process adds about 1:20 to the third timing for Microproof or Microspell.*

	Misspelled Words in File	Words Found Suspect	Words Wrongly Found Suspect	True Mis-spellings Found	Misspelled Words Missed	Time to Proofread File	Time Until Ready to Correct	Time Until All Corrections
Microproof	10	109	99	10	0	1:09		4:28
Microspell	10	55	45	9	1	2:15*		7:15**
Spellguard	10	151	141	10	0	1:06•	4:40••	6:35
The Word	10	52	42	10	0	2:05'	4:52''	6:42
Wordsearch	10	517	507	10	0	1:06°	10:21°°	13:31°°°

* Using the switches that suppress display of context and creation of an output file of suspect words.

** Microspell does not require a text editor to make corrections. However, since Microspell accepted an incorrect word in this file, correcting that word required running the text editor and saving the file. When Microspell misses a word, about 1:20 must be added to the timing shown.

• Skipping the regular word review, going to the special word review, and asking that all suspect words be listed at once (Option L on Special Word Review Menu).

•• Time to proofread, review suspect words one by one, mark legitimate errors, load WordStar, and call up text file to start making corrections.

' Time to proofread and list suspect words found.

'' Time to proofread, load WordStar, use WordStar to edit list of suspect words, save shortened file of suspect words, run The Word's MARK program while still inside WordStar, and call up marked text file to make corrections.

° Running the Scan function followed by the List function.

°° Time to proofread file, assign words to one of three groups, print a list of confirmed misspellings, load WordStar, and call up unmarked text file. Wordsearch neither marks errors nor corrects.

°°° Since Wordsearch doesn't mark errors, each misspelled word had to be typed in as a search string, and that added to the time required to make corrections.

Table 4: *Performance of the proofreading programs on a 3000-word text file. The same comments apply as in the caption for table 3.*

display a list of suspect words, that isn't the standard procedure. To achieve that timing, I skipped the regular word review and took the List option on the Special Word Review Menu—calling for a display of all the suspect words at once. In normal use, running Spellguard takes longer because suspect words are presented individually to be marked in the text file, ignored, or added to the dictionary. But Spellguard lets you dispose of each word so easily that you can quickly consider each suspect word and pare a long list down to manageable size. When I proofread the same 400-word file using Spellguard's regular step-by-step word review, I needed only 50 seconds more to deal with forty-seven suspects, and that includes the time Spellguard needed to mark errors in the text file. Once the larger Spellguard dictionaries appear, the list of suspects should be shorter and even easier to deal with.

Before making corrections, I had to change disks and run WordStar, my text editor, and call up the text file. Those steps took an average of 45 seconds. So a minimum of 2:31 passed before I could use WordStar's Find command to locate marked words and make corrections. I completed the corrections and saved the corrected file in another 1:09, a total of 3:40.

Proofreading the 3000-word file and listing all suspect words took only 1:06. Reviewing each suspect word and marking legitimate misspellings took another 2:49, a total of 3:55. Loading WordStar to start making corrections brought the total to 4:40. I had run WordStar, made all the corrections, and saved the file after a total of 6:35.

I have two criticisms of the version of Spellguard I used. The first criticism will no longer apply by the *time* this article appears, and the second is minor. First, Spellguard identified too many suspect words. In the 3000-word file, Spellguard found 151 suspects and there were only ten misspellings. The excess of suspect words resulted from the present dictionary's limited size, and the upcoming data-compressed dictionaries will remedy this problem.

Second, I felt a slight annoyance at having to restore the last character of each marked word (Spellguard *replaces* the last character of a misspelled word with an error mark). If the actual spelling error occurred early in the word, I thought Spellguard was entering a second error and requiring me both to delete the mark and replace it—two keystrokes plus any other corrections needed. These added keystrokes made correcting files marked by Spellguard take more time than files marked by The Word. On the other hand, by replacing the last letter of a bad word instead of adding a character to the word, Spellguard avoids disturbing the format of text in the file. You can't have it both ways.

Spellguard handles hyphenated words by displaying both halves of the word and indicating whether the word occurred at the end of a line. That makes it easy to check the correctness of both the spelling and the hyphenation. Since Microspell and The Word treat hyphens as spaces and report the broken parts of words as two suspect words, Spellguard has an advantage here. The advantage is partially offset because Spellguard reports *all* compound words as suspects. So Spellguard made "import-export" suspect, but Microspell and The Word considered the compound correct. In the 3000-word text file, Spellguard reported nine compound words as suspects; in the same file, Microspell reported fifteen hyphenated word fragments as suspects, The Word reported sixteen, and Microproof thirteen. Microproof also listed ten compound words as suspects.

The User's Guide—The user's guide for Spellguard is excellent. The writing, organized around the program's screen displays, makes its point without resorting to jargon or inflated language. A plastic three-ring binder holds 116 pages of sharp print quality, including a table of contents, an index, and a glossary. The Spellguard user's guide would probably make Spellguard the best proofreading program for general use in offices.

The Word Version 1.1

The Word is a program of beautiful simplicity. Its SPELL program proofreads a file and gives you a list of all the suspect words. The author, Wayne Holder, sought to create a set of tools for people who work with words. Each of The Word's seven programs is designed to meet Kernighan and Plauger's definition of a software tool: a program that is general and yet simple enough to have widespread application. Each of the seven programs works quickly and performs a valuable task. Holder envisions adding more useful programs to The Word's toolbox. For writers and editors, The Word already offers far more than just a proofreading program.

The Package—In addition to the 160 K-byte dictionary, The Word includes seven programs: SPELL (4 K bytes), MARK (2 K bytes), WC (2 K bytes), DICTSORT (2 K bytes), WORDFREQ (2 K bytes), FIND (2 K bytes), and LOOKUP (2 K bytes). SPELL proofreads a text file and lists the suspect words. MARK puts an asterisk at the beginning of each suspect word in the text file. WC counts the words in the text file. DICTSORT alphabetizes words and eliminates redundancies from the resulting list. Use it on your own text files and discover what your working vocabulary is. WORDFREQ shows you how many times you use each word in a text file, a fast and valuable check on style. FIND searches the dictionary for words that conform to a character pattern (using CP/M "wild card" characters for the unknown letters in the pattern).

LOOKUP is a remarkable little program that takes a misspelled word and "un-misspells" it, looking for words that can be derived from the misspelling by adding one letter, dropping one letter, changing one letter, or reversing two letters. The program often finds the right word and finds it much faster than you could with a printed dictionary. One new program that will appear in the forthcoming 2.0 version will let the user review the list of suspects one by one and decide whether to mark each suspect, add it to the dictionary, or ignore it. The review program will not be integrated with SPELL, so the user will have the option of listing all suspect words at once. On the more distant horizon, The Word may even include heuristics to help cope with the problem of homonyms (like "fare" and "fair") in the proofread document.

Dictionary—The Word's dictionary is large and literal.

Main/Frames from **$200**

It packs more than 45,000 words into only 160 K bytes of disk space. The Word's dictionary also uses cross-referencing to speed access to its contents. Oasis Systems based the dictionary on *The American Heritage Dictionary of the English Language* (Boston: Houghton Mifflin Company, 1979), and used data-compression techniques. One of the methods of compression is simple: when two successive words have common letters at the beginning, the common letters are replaced in the second word by a 1-byte count of the common letters. If the word "power" is stored literally, the word "powerful" is stored as "5ful." If "eccentric" is already present, "eccentricity" is compressed to "9ity." The increased dictionary size made possible by data compression pays off in a dramatically reduced number of words reported as suspect. A new version of the dictionary, using additional data-compression techniques, will soon be available. The 45,000 words will occupy only 136 K bytes and will make The Word's programs run even faster.

Performance—The Word took 1:39 to proofread the 400-word file in figure 1 and list the suspects. With the present version of The Word, you have to use your text editor to eliminate correctly spelled words from the list of suspects before marking the errors. Since The Word's large dictionary prevents SPELL from defaming many innocent words, this editing chore takes little time. Furthermore, you'll have to reload your text editor to make corrections anyway. (As noted earlier, a program for reviewing suspect words one by one is on the way.)

Here's how I used The Word with WordStar. I ran The Word's SPELL program with the $F switch, which makes The Word write the list of suspect words to a file. Then I ran WordStar and edited the list of suspect words, deleting those that were in fact correct. Next, I saved the shortened list of suspect words and, from inside WordStar, used WordStar's R command to run The Word's MARK program. Then I called up the marked text file for editing.

To do all this with the page of text shown in figure 1 took me a total of 3:15. On the 400-word file, The Word got me to the point of being ready to make corrections only 34 seconds later than Spellguard. And correcting the file marked by The Word took 24 seconds less than correcting the same file marked with the same corrections by Spellguard. The reason? It takes a few seconds more to retype the character replaced by Spellguard's error mark. The Word's mark doesn't knock out any characters, so none have to be retyped.

It took The Word 2:05 to proofread the 3000-word text file. The total time increased to 4:52 when I invoked WordStar, edited the list of suspect words, saved the shortened file of suspect words, ran MARK, and called up the text file for editing. I made the corrections and saved the file after 6:42. That's only 7 seconds slower than equivalent operations took with Spellguard.

The User's Guide—The guide to The Word is simple and clear. It separately describes use of each of the programs. Since The Word isn't organized around screen

I'd had the joint staked out for two years and nine months. I'd been waiting for a break in the investigation all that time. This looked like the break I'd been waltzing for.

The tall stranger walked up to the bar, ears akimbo. I knew he meant trouble from the moment I saw the insignia on the back of his black leather jacket: "Hell's Twirps." That was the same gang that peddled into the all-Mahler Philharmonic concert last year and hummed the collected works of John Cage in unison. Not that John Cage has ever been in unison. Quite the canary.

Why was this particular Hell's Twirp barging into the only Austro-Mongolian fife and drum factorial east of the Rockies? Why wasn't he ridding his unicycle? And what was the meaning of the gold mandalas hanging from the tips of his handlebore mustache? Then I saw his baton. The sight of its sleek crome length turned my bblood to issicles. When I glimpsed the white plastic knobs at the ends of the baton, I saw my whole life rush before my eggs.

Suddenly the Twirp slammed his fist down on the bar. His ears swayed gently in the breeze as he demanded, "Give me four hundred snare drums to go! Give me the five longest fifes in your inventary! Give me the old college try! Give me liberty or give me grief!"

I knew better than to let this build to a crisis before interseeding. I swizzled up behind the big Twirp and said, clam and easy like, "Shove off, Twirp. Vamoose. Leave well enough aloft."

He whirled, ears slashing, baton twirling. I thought of the health-insurance premiums I hadn't paid. I realized how happy I would have made my dear old father if I'd only gurgitated from college. I thought of the thousand times I'd wanted to be where I wasn't, and knew this was the thousand and first. If I had'nt been in a connubial mood, I wouldn't have been able to stand up to the singing shroud, the short shrift and the five and dime. But I had no time for all that now. Before it was too late, I reached into my vest pocket and pulled out my well-thumbed copy of Milton's Areopagitica.

"That'll be seven ninety-eight!" the bartender suddenly screamed.

I'd been counting on him.

Figure 1: *The 400-word text file proofread by all five programs. Results are shown in table 3. The zaniness is intended to show the kinds of mistakes from which a proofreading program can't save you.*

displays, the guide isn't either. The programs are easy to use and the guidebook gives just enough explanation and examples.

Microspell Version 4.1

Microspell is the most interactive of the proofreading programs. Author Bob Lucas started work on Microspell after experiencing spelling problems while writing his thesis. He wanted to create a single program that gives the user fully integrated means of finding spelling errors, looks up the intended words in the dictionary, and makes corrections on the spot. He modeled Microspell after existing programs for larger computers.

Frankly, I didn't like Microspell at first because it seemed to take too long. But the more I used Microspell, the more I liked it, and the time required to run the program decreased dramatically as I became more accustomed to it. Microspell shows you each suspect word in its original context and gives you several options for dealing with suspects then and there. If you don't spell well and want to save trips to the dictionary, Microspell's Guess and Probe functions may help you find the right spelling quickly. The Probe function is much like The Word's FIND program, but Probe works from inside Microspell's large integrated program. Once you've recognized the correct spelling, you can immediately make the correction in the original text file by using the Replace command.

A coming version of Microspell will give users the ability to spread the dictionary over several disks, as well as improved logic for handling hyphenation at the end of a line (where a carriage return and line feed separate the two halves of a word). Lucas also is working on a patch program that will let the user change Microspell's defaults.

The Package—In addition to dictionary files that add up to 178 K bytes, Microspell contains SPELL (14 K bytes), BUILD (14 K bytes), INVERT (8 K bytes), and EMPTY (2 K bytes), as well as help, demonstration, and documentation files. Only SPELL and the basic dictionary (128 K bytes) are needed for most Microspell operations. BUILD incorporates a list of words into the dictionary. EMPTY gives BUILD an empty dictionary to use as the basis for a new dictionary of the user's creation. INVERT lets you view the dictionary or remove words from it.

Dictionary—Microspell's distribution dictionary contains 20,000 words in four files totaling 128 K bytes. The basic vocabulary was taken from Thorndike's list of the 20,000 most frequently used words. Two additional vocabulary files are included in the package. Called ING.VOC and ED.VOC, these files are incorporated into the dictionary if your disk size permits. ING.VOC is 20 K bytes in size, and ED.VOC is 30 K bytes. I was able to squeeze in all of ED.VOC and three-fourths of ING.VOC. That gave the dictionary 26,000 words in 154 K bytes of disk space.

Microspell's dictionary handles about the same range of words as The Word's 45,000-word literal dictionary. That's primarily because Microspell can identify words in text by stripping a suffix and checking the spelling of a word root. Microspell also accepts many plurals on the same principle. Microspell's dictionary relies on the suffix-stripping routines, rather than on data compression, to extend the range of the words it covers.

The only trouble, as the Microspell manual points out, is that the suffix-stripping routines are sometimes wrong. As an experiment, I made up some nonwords out of roots and suffixes. Microspell accepted abstractment, abhorrities, boathood, boatize, hairful, footish, mountainette, and theaterhood; it rejected discontinerary, condications, abominition, abettulate, ligamentury, nutticulate, vocabutation, writathlon, safetydom, and theatricate. In use, Microspell shows how it forms a word from root and suffix, so you can catch a mistake if you are observant and willing to check Microspell's work against a printed dictionary. But you can't correct such a mistake without exiting Microspell and running a text editor.

Performance—It took Microspell 1:06 to proofread the text in figure 1 and display a list of the misspelled words. That isn't the normal method of operation and doesn't mark or correct errors in the text file. Running Microspell in the normal way, reviewing one suspect word at a time, takes longer. The time required depends on the proficiency of the person running the program. My first few runs of Microspell were far slower than the ones reported here.

Microspell's ability to correct errors in the text file seems a big advantage over Spellguard and The Word. It took a total of 2:47 to run Microspell this way and correct all but one of the errors in the text in figure 1. (I'll say more about that one error later.) Spellguard took 1:46 to find and mark the errors, but then I had to change disks and run WordStar. Microspell proofed the text file and corrected all but one of the errors in about the same time Spellguard took to find and mark errors, plus the time needed to load WordStar and call up the marked text file. We would have to compare the 3:17 Microspell took with Spellguard's 1:46, *plus* the time necessary to use WordStar to make all the corrections in the original file and save the corrected file. Microspell's 2:47, then, has to be compared to Spellguard's 3:40. In general, Microspell has the edge on short files because the time needed to load a text editor after running the other spelling programs is a larger proportion of the total time required for the whole process of finding and correcting errors.

Except for that one special error, Microspell would have the clear advantage the correcting feature seems to offer. But that error, the nonword "inventary," was displayed as a correct word. Microspell doesn't let the user alter any word it considers correct. So I had to note the word, load WordStar, find the unmarked word, and correct the misspelling. Loading WordStar might also have been necessary if any correction changed the length of a word; such a change might destroy the text's alignment, especially if the text is justified. Microspell lost its edge because of accepting the bad word. For a fair comparison with Spellguard and The Word, add about 1:20 to Microspell's timing of 2:47. That's a total of 4:07—27 seconds slower than Spellguard and 7 seconds slower than The Word.

Microspell proofread the 3000-word text file in 2:15 (the quick way). But it took 7:15 to proofread the file step by step and make corrections. That's about 30 seconds longer than it took me to proofread and mark the file with The Word and correct the file with WordStar, and about 1:32 longer than the whole process took with Spellguard. Microspell found fifty-five suspect words, including all but one of the misspellings in the file. This time Microspell was willing to accept the word "stewardes." So I had to run WordStar afterward to correct that, and that added about 1:20 to Microspell's timing. The time required to handle this file was about 8:35—almost three minutes slower than Spellguard and two slower than The Word. But don't forget that Microspell lets you look at the context of a suspect word and lets you probe the dictionary for a correct spelling. Those features may help you decide whether a suspect word is right or wrong, and may hand you the correct spelling on the spot, saving time-consuming trips to a printed dictionary.

The User's Guide—The Microspell user's manual contains twenty-nine pages of single-spaced, photo-offset material stapled between pasteboard covers. The print quality is good, the writing clear, and the organization sound. The manual includes a detailed table of contents, an overview of the program, summaries of the commands, switches, and error messages, and instructions for using each of Microspell's four utility programs. Two pages from a sample run of Microspell let the user know what to expect from the program. The manual's three-page explanation of the program's limitations would satisfy any consumer protection agency. A revised edition of the manual has just been released but did not reach me in time for inclusion in this review.

Microproof (CP/M Version)

If your disk space is extremely limited, Microproof may be the best proofreading program for you. On my system, I had room on a single disk for all the WordStar files, the Microproof dictionary, and Microproof's proofreading and correction programs. Furthermore, I was able to run both the Microproof proofreading program and the correcting program from *inside* WordStar. That's real convenience. And Microproof is very fast and reasonably accurate. By using root-suffix and root-prefix routines and data compression, author Phillip Manfield has made the 70 K-byte dictionary act like a literal dictionary of about 30,000 words. Manfield's inspiration? His thesis was riddled with misspellings, and someone told him it was impossible to write a good proofreading program to run on a system as small as a TRS-80 Model I. (Microproof *does* run on Model I, II, and III TRS-80s.)

The Package—The standard Microproof package includes the proofreading program MICPROOF (10 K bytes), the dictionary-building program ADDTODIC (4 K bytes), and three dictionary files that total 72 K bytes. I strongly recommend the optional correction program CORRECT (4 K bytes) because Microproof can't mark errors in the text file. Without the correction program, you'll have to type in a long search string for every bad word, using your text editor's Find function. Counting CORRECT, MICPROOF, and the dictionaries, Microproof gives a complete proofreading system that performs well and occupies only 86 K bytes of disk space.

Dictionary—Microproof's data-compression technique includes replacing all roots with one-character tokens. The dictionary is based on *Webster's Pocket Dictionary* but is not nearly that large a literal dictionary. Much of the dictionary's vocabulary comes from prefix-root and suffix-root logic. Suffix routines accepted abstractment, hairful, and footish, but rejected abhorrities, boathood, boatize, mountainette, theaterhood, discontinerary, condications, abominition, abettulate, ligamentury, nutticulate, vocabutation, writathlon, safetydom, and theatricate. Prefix routines accepted inclosed because they treat a prefix and root as separate words: "in" and "closed."

Each word is identified to the dictionary as a verb, a noun, an adverb, or an adjective, or as more than one of those parts of speech. Knowing the part of speech helps the suffix and prefix routines avoid accepting some plausible but illegitimate words.

Performance—Microproof proofread the 400-word file in only 45 seconds. The program found thirty-two suspect words, six of which were in fact misspelled. Microproof missed one misspelled word. The program's prefix routine accepted interseeding, which Microspell rejected; on the other hand, Microproof's suffix routine rejected inventary, which Microspell accepted.

Microproof recognizes some hyphenated words as single compound words and treats others as two-word fragments. It ignores all single-character words, so if you mean "I" but type "J," Microproof won't let you know.

On the 3000-word file, Microproof took only 1:09 to find 109 suspect words, including all ten misspelled words. It rejected stewardes, which Microspell accepted. Microproof's prefix and suffix routines made no errors on this file.

The User's Manual—The Microproof manual is reasonably clear, but could use refinement. Its problems, all minor, stem from the manual's need to deal with both CP/M and TRSDOS, the TRS-80 operating system. Since I received Microproof, Cornucopia has developed the manual from an outline into an adequate user's gu.de. The manual includes facsimiles of screen displays and the print quality is good. More and bigger staples would help the manual withstand intensive use.

Wordsearch 1.03

Wordsearch is the only noncontender in the group of proofreading programs.

The Package—In addition to its dictionary (72 K bytes), Wordsearch includes the programs SEARCH (10 K bytes), WDS, WDL, WDA, WDT, WDM, and VIEW. All but SEARCH and VIEW are 4 K bytes in size, and VIEW is only 2 K bytes. SEARCH works by letting you access the smaller programs. It uses WDS to scan a text file for suspect words, WDL to list the suspect words, WDA to assign each suspect word to one of three groups, WDT to display the text file with suspect words highlighted, and WDM to merge good words with the dictionary. The reason for displaying the text with suspect words highlighted is mysterious, because all you can do is look; you can't reassign or mark the words.

Wordsearch provides no means of either marking suspect words in a text file or correcting misspellings. As

My Hardware

I ran the proofreading programs on my SuperBrain computer. My timings are slower than some of those advertised for the programs reviewed, but that doesn't mean the advertisements were false. On systems with larger disks or hard disks, all the programs should run faster. For SuperBrain users who have one of these programs but can't match my timings, the operating system I use (SB/E, from IE Systems of Newmarket, New Hampshire) performs disk operations about one-third faster than the standard SuperBrain operating system. Also, do not try putting the larger Spellguard dictionary or The Word's dictionary on a single disk. My operating system can handle 188 K bytes per drive, opposed to the standard 161 K bytes.

a result, the user has two choices. The first is to print on paper a copy of the entire text file with confirmed misspellings underscored (or in bold or surrounded by double parentheses, at your option). For a text file of any size, the time required for printing, unless you have an extremely expensive printer, is sufficient to prevent Wordsearch from being competitive with other proofreading programs. Furthermore, after the file is printed, you have to work from the printed copy while using a text editor on the original unmarked file. Visual checking between paper and screen is time-consuming and far less accurate than using the search command of a text editor. Besides, if you'd been satisfied with the efficiency of working on paper, you wouldn't have bought a computer in the first place.

The second choice is to have Wordsearch print an alphabetical list of confirmed misspellings. This way, you need less time to print, but you have no idea where the errors are located. So you work with the text editor's search command. But that poses problems, too. Since Wordsearch doesn't use a mark character, you have to type the full misspelled word when you use a search command. That requires more checking between paper and screen and raises the possibility of making a typographical error when entering the string to be searched for. To make matters worse, since the list of misspelled words is alphabetical rather than in the order of occurrence in the text file, you often have to return to the beginning of the file to start the next search (or else use a global search, which is slower).

Wordsearch might deserve reevaluation if Keybits added a large dictionary and a means to mark errors in the original text. Unfortunately, Keybits plans no major changes in Wordsearch in the near future.

Dictionary—The dictionary I received with Wordsearch contains 7200 words in 72 K bytes. Rather than making the dictionary from a list of the most frequently *used* words, Keybits worked from a list of the 10,000 most frequently *misspelled* words. As a result of this approach and the dictionary's small size, Wordsearch considers the following words suspect: arm, baby, calm, catch, choices, assets, businessmen, chief, cover, dark, eyes, dinner, doubts, knew, land, life, thought.... You get the idea.

Why did Wordsearch take this approach? The user's guide says, "...ones [sic] written word vocabulary is a major subset of his total word vocabulary and varies from person to person. It is for this reason that we have provided a starter library of several thousand words, many of which are variations on the same word...Over time however, it will be necessary to add fewer words in order to stabilize your own tailored writing environment." If you can ignore the redundancies and mixed metaphors and somehow live with the knowledge that your environment has learned to write and tell the world what you're really like, you can get the message: Wordsearch assumes that everyone will write his or her own dictionary. Al Clark of Keybits says that after three months of adding words to the dictionary, the average user can expect Wordsearch to report only one or two suspect words each time it's run. Keybits has a 50,000-word dictionary on disk, but Clark says there has been no demand for it from Wordsearch users.

If you consider yourself in the same league with Samuel Johnson, Noah Webster, and the *Oxford English Dictionary's* Dr J A H Murray, and if you have three months to devote to writing your own dictionary, Wordsearch is the proofreading program for you. But if you want to buy a program today and proofread a letter tomorrow, Wordsearch won't help you much.

Performance—In the 400-word text file, Wordsearch found 105 words suspect. It listed the suspect words on the screen after only 55 seconds. But the list was of little use until I'd used the assign option to confirm which words were misspelled and then used the text-display option (with the /OY switch) to print the file with the misspelled words underscored. Using the assign option took 2:55 to review the 105 suspect words. Printing the file brought the total elapsed time to 4:11. Making the corrections with WordStar and saving the corrected file took another 1:37, for a total of 6:13.

Things were worse when I used Wordsearch to proofread the 3000-word file. Wordsearch needed only 1:06 to proofread the file and list 517 suspect words on the screen, but it took me 8:15 to assign these words to one of three groups. Printing the whole file with misspellings underscored took more than 11 minutes. I abandoned that approach and started over. This time I just had the program print a list of confirmed misspellings. That took only 15 seconds, so I'd saved almost the full 11 minutes. But when I edited the file and used the search command to locate misspellings, I had to type in each string exactly. Since the list was alphabetical, I often had to return to the start of the file to initiate a new search. Alas, making the corrections and saving the file took another 3:28, so the total came to 13:49—roughly double the time required by any of the competing programs.

The User's Guide—The Wordsearch User Manual is incomplete, overwritten, and poorly organized. It stands as a Great Wall between the user and the program. The introduction says, "To take full advantage of this manual, begin by trying each function and feature at your terminal as you review it in the manual." A careful check revealed that my terminal was *not* in the manual. The system overview begins: "Wordsearch is a spelling word dictionary lookup system." That sounds like an attempt by a word, miraculously blessed with the ability to spell, to look up a dictionary. The Wordsearch User Manual sells for $45. I'll bet the National Museum of Obfuscation, Redundancy, and Misplaced Modifiers would pay twice that amount for it!

Conclusions

Spellguard, The Word, Microspell, and Microproof should all win a place in the market for automatic proofreading software. Which program is best for you? That depends on which features you consider most important.

The Word and Spellguard are the most accurate programs because they use literal dictionaries. At this writing, The Word's dictionary is larger and occupies less disk space.

Spellguard, once its larger dictionary appears, will probably be best for the office because of its menu-driven operation. But The Word merits consideration there, too, because all its operations are so simple.

If you want your computer to look through the dictionary and propose alternatives to a misspelling, choose between Microspell and The Word.

If you prefer a single integrated program that does everything from proofreading to guessing the intended word and correcting the error in the original file, you'll go for Microspell. Because of its suffix-stripping routines, Microspell is slightly less accurate than the packages with literal dictionaries.

If you have limited disk space, Microproof offers big-dictionary performance through data compression and suffix-prefix routines, at some sacrifice of accuracy.

If you want a good proofreading program, but also want other features useful to writers and editors, you'll buy The Word.

My own preference? I like great accuracy, a large, literal dictionary, and a marking feature. I also like a program that can look up words in the dictionary on disk. Furthermore, I like to see a list of all suspect words at once. Since I'm a writer and editor, I find word-frequency software useful, and I'm usually short of cash. By far the least expensive of these programs, The Word has no shortcomings I've been able to find. I've already mailed my check for $75 to Oasis Systems.■

[While correcting the proof of this review, I received version 2.0 of The Word and I couldn't resist testing it. On the 400-word text file, it found the same number of suspect words as before, but the program works faster now. The Word took only 1:28 to proofread the file and list the suspects. The new REVIEW program eliminated the need to use WordStar to edit the list of suspects. With REVIEW, I needed only 26 seconds to review the suspects, and only 7 more seconds to mark the confirmed misspellings. I had loaded WordStar and was ready to correct after 2:46. I completed the corrections and saved the file in only 3:31.

On the 3000-word file, The Word 2.0 showed improved handling of WordStar's soft hyphens. As a result, it found only 38 words suspect, only 28 wrongly so. Moreover, The Word 2.0 proofread the file and listed the suspects in only 1:43. REVIEW enabled me to review the suspects in 31 seconds; MARK marked the confirmed misspellings in 28 seconds. (Reviewing and marking took 2:49 with Spellguard, but only 0:59 with The Word 2.0; the short list of suspects helps a lot.) I had loaded WordStar and was ready to correct after 3:27. It took another 1:50 to make the corrections and save the file, for a total of 5:17. For combined speed, convenience, and accuracy, I think The Word 2.0 has far surpassed its competitors. And it still costs only $75.]

User's Column

New Software, New Hardware Computer Languages, and Games

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"Read any good books lately?" asked my mad friend Mac Lean.

Having just come back from an autograph party for *King David's Spaceship*, and the day before sent off the copyedited manuscript for the new Niven-Pournelle *Oath of Fealty*, I knew what to say. "Haven't had time. But I've *written* some good books lately...."

"Yeah, well, I wasn't talking about science fiction," said Mac Lean. "I meant good books on computers. I've got a dilly." He held up *PL/I : Structured Programming*, by Joan K Hughes.

"Hey, I know her," I said.

"Well, you tell her for me she's written a really top book. Good index. Clear English. Stand-alone chapters, so you don't have to thumb back and forth to find out what's going on."

"I'll do better than that," I said. "I'll tell my readers."

"Yeah. Sure. When?"

"Uh, real soon now...."

* * *

My apologies for taking so long in finishing this column, and my thanks to all of you who've written encouraging letters. Things do get hectic here at Chaos Manor, and the last few months have been something to see: books to get done, articles to write, and I built a new wing on the office, which meant moving everything around like Chinese Checkers, which meant that I lost the documentation to half the software sent me for review, which—

I am also, for my sins, Chairman of the Citizens Advisory Council on National Space Policy, which involves chairing meetings and editing papers and writing summaries and flying to Washington. The result was that for a good while I had no time to play with Ezekial, my Z80, but things are a bit caught up now, and maybe we can get onto a schedule. Just last week I had a surgeon remove the telephone from my ear.

One reason we got caught up was Spellguard.

Every now and then you find programs that do things right and have documentation that tells you what to do and how to do it—programs that are a joy to use. Spellguard is like that. (See the reviews of Spellguard, Microspell, the Word, Microproof, and Wordsearch on pages 434-448.) Spellguard finds spelling errors. That's all it does. It doesn't wash dishes, or set your clock, or do your taxes, but wow! can it find spelling errors in standard ASCII text files. And it doesn't care what editor you used to create the files.

Using Spellguard is simplicity itself. All you do is tell it what file to look at. It does the rest. It does *not* do it as fast as the ads say—at least it doesn't with Zeke, but then he's only running at 2 MHz, and my ancient iCom drives, while utterly reliable, are pretty slow. Help is on the way: I've got a pair of Lobo's 8-inch drives, and they've promised an S-100 double-density controller next month. If the controller is as fast and reliable as their drives, things are going to hum around here. We've been using Lobo drives (both 8-inch and 5¼-inch) on the boys' TRS-80 for months now, and we love them.

Meanwhile, Spellguard runs fine under Speed, a rather strange program available from the CP/M User's Group. Speed trades memory for rapid disk I/O, and if you have programs that don't use a lot of memory but have a lot of disk operations, Speed can cut running time dramatically. For Spellguard the saving is about 50%; the saving in posting my journals to ledgers is even more dramatic—70%.

Speed, with auxiliary programs to get it running properly, is available on Volume 38 of the CP/M User's group (CPMUG) disks. Those with access to a computer net may be able to find it in an on-line file. You need a bit of patching with DDT to install SPEED, but the documentation (also on CPMUG Disk 38) is clear enough.

One warning, though: Speed maintains the disk directories in RAM (random-access memory), and if you change disks without rebooting (in Speed that's control-B, rather than CP/M's control-C) the result is an unmitigated disaster!

But back to Spellguard. When you run Spellguard, it first gives you a table, telling you how many words it has read, the number and percentage of unique words, the number and percentage that it can't find in the dictionary, and finally a changing column that tells you the percentage of proofreading the program has done.

Many years ago, when I was young and impressionable, I fell under the spell of a science fiction writer named A E Van Vogt; later he became a friend, neighbor, and colleague. Van Vogt was (and still is) interested in a rather hard-to-define field of study called general semantics, and through him I was led to Alfred Count Korzybski and a strange book called *Science and Sanity*. That led me to Wendell Johnson at the University of Iowa. Professor Johnson's interests spanned everything from classical linguistics and speech therapy to general semantics.

One of Johnson's research interests was identifying text: how could you tell if an anonymous work had been written by a particular author? Dr Johnson used a number of quantitative measures, two of the most important being the type/token ratio and the verb/adjective ratio. Type/token means the ratio of unique words to total words; verb/adjective is self-explanatory. I remember going nearly blind counting total words and making tables of unique words in, for example, Marlowe's *Duchess of Malfi*; the idea was to find out if Marlowe had written any of the Shakespearean plays. (As best we could calculate, he hadn't.)

Now Spellguard gives you automatic type/token ratios, and if you really want to, you can make up separate verb and adjective dictionaries, thus finding the ratio merely by typing in the text, which, believe me, is a great deal easier than doing it in teams of two with pencil and paper. Spellguard, with its efficient search algorithms, could be extremely useful in linguistic research projects.

Anyway, if you work with text at all, you'll love Innovative Software's Spellguard. It is an example of excellent software: a program that does one thing, does it very well, and has documentation to match.

Datebook and Milestone

Organic Software of Livermore, California, has also produced two excellent programs that I recommend, although I'll probably never use them.

The first, Datebook, can keep track of about six months' worth of appointments for three people. We had no trouble getting it to run, and it seems to be easy to use. The main drawback is that you have to *want* to run it; Datebook requires both disk drives and all of your microcomputer's memory. What I want is Calendar, a program that I may have to write myself; it would come up when I turn on my system, insist that I give it the date (the way Lobo's LDOS operating system does), and then natter at me about what I have to get done. But it's fairly obvious that I can't write *that* program until I have hard disks with multimegabyte storage.

Calendar would solve my problem: I forget to look at my appointment book until it's too late. And that raises a question: is Datebook really better than an appointment book of the kind used by many physicians and lawyers? I can't answer that, but my guess is that I wouldn't buy a computer for that *alone*. Datebook has various search patterns, so you can look for appointment openings of stated lengths, and the program offers up to nine candidates—but you can do that by glancing at a book, too.

The value of Datebook is that it will keep three schedules simultaneously, so you can work appointments with your partners (it searches for times when you're all free). It will also search through and find all the appointments you've made with a particular person—a task that is more difficult and certainly more tedious if you must rely on visual inspection of a book (especially if there are a lot of entries). And of course Datebook can make hard copy, and update that often. All in all, if I worked in a business where I had lots of appointments and schedules, I'd probably use Datebook, but then I'm gadget-oriented—and I *have* a computer.

Organic's other interesting program is Milestone, and people who need it will like it a lot. Milestone is a PERT-chart generator. It performs critical-path analysis for jobs with up to 300 tasks; it computes milestones (critical events), monthly manpower levels, monthly costs—in short, it handles most of the details we used to have to include in the management-plan portion of a research proposal.

Milestone isn't easy to use. In fact, it's almost impossible to use on my system because I don't have a 24 by 80 terminal. I use a memory-mapped 16 by 64 video display, in part because I still use the old-fashioned Electric Pencil as a text editor, and Pencil requires it, in part because I like the smooth scrolling and fast response, and in part because I'm lazy and have never gotten around to buying a terminal. That's going to change one day.

Anyway, Milestone isn't easy to use, not because the directions for the *program* aren't clear (they're only fair), but because PERT charting and critical-path analysis are more arts than sciences, and not easy jobs. Milestone can make the jobs easier, and if I ever again have to generate research proposals, I'll certainly use Milestone.

One of my pet peeves is documentation without examples. I can't imagine why people write instructions on how to use a program but fail to include specific illustrations of what command to issue and the results.

Let me illustrate. Suppose I am opening Milestone after not looking at it for a couple of weeks (as indeed I am). I turn to page 36, and there I find:

> "B(egin) and E(nd) work
> These two values define when the normal working day begins and ends. They must be even hours as defined on a 24-hour clock. Follow the rules for entering integers rather than times."

Now I ask you, what does this mean? Presumably, I once knew, but I confess I've forgotten. Indeed, some of us go days on end without even thinking about computers!

I don't want to be too hard on Organic; Milestone, in fact, comes with a set of example cases. One is Dr Victor Frankenstein III's PERT for creating a monster. Event One, "Fanatic Desire to Create Life," is a milestone; it has no duration, but you don't start without it. We proceed to Task Two, "Move to ancestral castle," and continue searching for Grandfather's notes, hiring a linguist, etc. As it happens, Organic ran this example as part of a demonstration for me at the San Francisco Computer Faire, and I can testify that Milestone is both fast and accurate. I thought up the need for a linguist to translate the notes. That broke into subtasks: advertise, interview, hire. I watched Burns VanHorne of Organic enter the new tasks. Milestone thought for a moment, then rearranged itself, because this information became part of the critical path. (Not long ago they sent a revision of Milestone and I notice that the tasks I suggested are now in the case study.)

So they have examples, in the sense of worked-out problems for their program, but they should have included specific examples all over their manual—and so should every other publisher. Please?

Debate on Languages

My last column, on languages, generated a lot of correspondence. Some was predictable: I wasn't sufficiently respectful of LISP, the LISt Processing language written in 1956 by my friend John McCarthy, and since improved and expanded by McCarthy and my collaborator, Marvin Minsky, and used by my friends and associates who wrote ZORK, and—in other words, please, I don't dislike LISP users.

What I said was that LISP was fine for special purposes, but it wasn't among the candidates for replacing BASIC.

For those offended, my apologies, but I remain unrepentant. LISP may indeed be a great language for professional programmers, as it certainly is for those working in artificial intelligence. Furthermore, if you're someplace where you can learn LISP easily—say MIT or Stanford—then by all means grasp the opportunity.

Most of us, though, don't have that opportunity. Even if you have access to MIT's LISP-teaching programs, it's going to take time—lots of time—to learn. The ideal way to learn LISP is to use it; it does have the great feature of being an interactive language (which is BASIC's great advantage). But the LISPs available for microcomputers are very limited (Minsky himself wasn't able to do much with the one I have), and it isn't likely that they'll get better—not with our present hardware. Come the revolution, when 32-bit machines with 256 K bytes of active memory and 50 megabytes of disk storage can be bought for $2000, LISP may then be the best thing available, but not now, unless you have very specialized needs.

In any case, this remains the *User's Column*, directed in large part toward nonprofessionals who are trying to make their small systems do useful things, and for those readers I don't recommend LISP. It can be fun to play with, and I'm glad Microsoft published it, but I doubt that microcomputer users will ever do more than play with LISP.

But the problem of languages has yet to be solved.

In theory, BASIC is an inadequate language. Listen to the hackers: they'll tell you that BASIC programs "are a maze of GOTOs" or that "you can't do structured programming in BASIC."

That isn't true. A good modern BASIC—say Microsoft's BASIC-80, or Software Systems' CBASIC—has *do while*, *if-then-else*, *case*, and nearly all the features Pascal has, plus string features that are a *lot* better than any Pascal I've seen, and decent I/O, which Pascal doesn't have at all. True, there are problems in BASIC that are easiest to solve with judicious use of GOTO statements, but it's certainly possible to write good BASIC programs without a single GOTO, and even easier to tame the GOTO so it never refers to anything outside a local modular block.

You *can* write top-down structured programs in BASIC. Best of all, you can write interactively, testing each step of the way, then test the program logic until it's working, after which you turn it over to Microsoft's BASCOM compiler, and wham. And for maybe 80% of the jobs you want a microcomputer to do, that's the best approach. It's almost certainly the fastest.

So what's wrong with it?

Plenty. First, BASIC still has a fatal flaw—no truly local variables. Passing parameters to a subroutine is hard, and controlling side effects (making sure you don't do something you didn't intend) isn't easy. You can reserve I,J,K,L as indices and set up "declarations" in remarks up at the top of the program, and with the new cross-reference programs you can *usually* find the side effects. Having done that, you still have trouble passing parameters, and if the program gets big, so that you'd like to compile it in chunks, you're out of luck. BASCOM doesn't permit decent chaining of programs, nor does it allow true compilation in parts.

In fact, the Microsoft BASCOM is not really the same language as its BASIC-80. In addition to the chaining problems, you can't use computed array sizes or common statements.

"But," protests the BASIC enthusiast, "that can be fixed. In fact, I bet you somebody at Microsoft is working on it right now."

True. And maybe, one day, they'll really fix the BASIC/BASCOM system. I hope so, because I find BASIC programs fairly easy to read and write. I expect you'd be able to buy a lot of programs in compiled BASIC right now if it weren't for Microsoft's disastrous policy of demanding royalties for every program compiled with BASCOM. Competition will take care of that; meanwhile, I use BASIC-80 with BASCOM for routine jobs, and a lot of my most useful programs are written in CBASIC.

There's so much investment in BASIC software—take Joan Hughes, author of the PL/I book that so impressed Mac Lean. Joan runs Executdata, one of the first of the small-systems houses that have sprung up everywhere. She sells turnkey systems for small businesses. The hardware she favors is the Vector Graphic S-100 bus Z80 with its "mindless terminal," which is really memory-mapped video. The software comes from all over. The editor is Vector's, and I'm tempted to buy a Vector machine just to get it; it's a lot like Electric Pencil but with most of the bugs out. Executdata writes other software or buys it commercially. Like all first-rate systems houses, they support everything they sell, and their customers seem downright enthusiastic.

The interesting angle is that the author of the best book we've seen on PL/I sells software largely written in CBASIC.

Why? Executdata has been around several years. When Joan first started the company, there wasn't a PL/I for microcomputers and CBASIC was the only BASIC that allowed long variable names (remember the horrible days when variables were "A$" and "B1" and you hadn't the foggiest what they referred to?) and structured concepts. She may change over, now that we have PL/I from Digital Research.

Digital's PL/I documentation is, if nothing to brag about, at least readable. PL/I-80 is a fairly healthy subset of the ANSI General Purpose (Subset G) PL/I, and it runs.

"Yeah, and so what," asked a friend. "Who'd use it?" "PL/I is unwieldy and inefficient," says a recent article in a magazine. On the other hand, Mac Lean has spent the last couple of weeks learning it and he loves it.

Meanwhile, I have—at last!—gotten not one but two Pascals that run, and I've been wading through Peter Grogono's *Programming in Pascal* (see references) and reading everything I can find on Pascal.

I recommend Grogono's book—for that matter, I recommend the Pascal/MT+ implementation of Pascal. It works, and unless Mike and Nancy Lehman have become liars, which I doubt, Pascal/MT+ is a full implementation of the Standard Pascal, along with a few much-needed extensions.

Their manual is improved, too. (They sent me an early copy, and apparently my anguished screams were too much for them.) They've added a number of sections, and, according to Nancy, "That's all because of you...."

I also have the Sorcim Pascal/M up and running. Pascal/M compiles to an intermediate code. It's slower than Pascal/MT+, but it's also more compact and more portable. It, too, has extensions to standard Pascal, and I recommend it.

What I don't recommend is Pascal itself. Not yet, anyway. When I first looked at Pascal several years ago, I thought it was the nicest thing I'd ever seen. But the more I look at it, the more misgivings I have. I certainly could be wrong, and I'll know more by next column time. And by then, Mac Lean will have done things with PL/I so we can compare notes.

Meanwhile, don't throw away your CBASIC; *they've* made some improvements, also (Compiler Systems' President Gordon Eubanks says) as a result of my reviews. The needless limit on the line printer width has been fixed, and the COMMON and CHAIN features improved. I think the latest version has some other improvements, too, but I've mislaid the new manual. Although I've said it before, it's worth mentioning again: the CBASIC documentation is excellent.

Gordon also tells me that by the time this is printed there'll be a new version of CBASIC that allows nested IF statements (fixing one of Joan Hughes's pet complaints), and before the end of the year they'll have parameter passing and local variables, and they're working on speeding it up.

The language situation isn't our only dilemma. Let's face it, our microcomputers are becoming obsolete. In one sense that's silly: we have more computing power than the government did ten years ago. The machines work reliably. And there's no point in replacing our machines just when we're finally getting good software.

But that's the problem: we're beginning to see hardware limitations on the new software.

Take Spellguard for instance. It's a good program. I use it often. But it can't touch *real* spelling programs like those that run on the big MIT computers. MIT's Spell (written, incidentally, in LISP) not only finds misspelled words—it shows you the word along with context, shows a menu of words it thinks might have been meant, offers you a chance to enter the new word in your permanent dictionary (if that's refused, offers the opportunity to put it in a dictionary kept just for this job), and, finally, lets you input the proper spelling, which it inserts into the text. It does all this at blinding speeds, searching dictionaries of 35,000 to 50,000 words. No 8-bit machine running floppy disks can touch that job. [Editor's note: *Don't be so sure, Jerry. See the review of spelling programs in this issue. ...PL*]

There are other limits. One controversy over text editors hinges on a simple forced choice: do you limit the amount of text you can work on to what can be held in memory (as Pencil does), or do you keep part of it on the disk (as WordMaster, WordStar, and Magic Wand do)? If you keep part on disk, you can't conveniently change disks: that can be a serious limitation if you want to bring in a chunk of an old file or make a quick copy of something you can't afford to lose. If you keep all the text in memory, not only are you confined to 10,000 words or less (with my system, anyway), but you encounter real problems if you want windows and multiple buffers or if you'd like the machine to do some computing on values in the text.

Obviously, I prefer Pencil's limits. I have Wand and WordStar, but I don't use them—Star because it natters at me (when was the last time you wanted to know line and column number every time you typed a letter?) and Wand because of the disk operations. (Word Master, on the other hand, is the best programming editor I know of.) None of the available editors, not one, can do what I'd really like them to—for instance, let me put equations in my text, solve them, and have the answers available as I write. (What I usually do is leave the text on the screen and turn to my programmable TI-59, and that's silly.)

Yet what I want isn't impossible—for big machines. MIT's MACSYMA can solve intricate equations, and its EMACS editor is inherently more powerful than anything we can implement on a microcomputer. I haven't seen them combined, but it wouldn't be that different if the memory was available.

New Machines

For a few years we'll exploit what we have, but it isn't going to be long before Zeke becomes the world's smartest terminal (two memory-mapped screens, a 20 K-byte PROM monitor to control printing and I/O, etc), while a new machine does the work. Only—what will the new machine be?

Two years ago everyone would have said "the Z8000." Now we just don't know.

Next, when we get the new machine, what will we use for an operating system?

Again, two years ago everyone would have said "UNIX, of course." And if we had UNIX, which is a fairly complex tree-structured operating system developed by Bell Laboratories, we'd also have answered the language question, since UNIX contains a C programming-language compiler and is written in C.

Now, again, we just don't know.

What went wrong?

First, there weren't any reliable Z8000 chips. Now that problem's fixed—but there aren't many available Z8000 computers, are there?

There is one. Onyx has a working Z8000, with UNIX and C, hard disks, and 128 K bytes of memory. They're being shipped as fast as they're being made, and according to their customers they work and work well. There's a good chance I'll have an Onyx running here in a few weeks and I'll be able to tell you a lot more.

Meanwhile, there's a serious rival to the Z8000 and UNIX: the dual 8085/8088, working on an S-100 bus and running Digital Research's operating system that looks a lot like CP/M and allows you to bring over most of your CP/M files. The 8085/88 won't run Z80 code, but then neither will the Z8000. It does execute 8080 code.

Bill Godbout sells an 8085/88 system, and Tony Pietsch, the engineer who built my system, recommends it, along with hard disks and dual-sided double-density floppies to back up the hard-disk system. Tony is building a Godbout S-100 system and there's a chance I'll get one for review. The Lehmans use a Godbout S-100 8085/88 system for their Pascal/MT+ and they're very happy with it, while Sorcim's president Richard Frank says they've got half a dozen running constantly and that you can pitch the Godbout box out a second-story window without hurting it.

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In other words, Z8000 with UNIX has respectable supporters, and so does 8085/88. Prices aren't quite comparable: the Onyx system costs more, largely because of the UNIX software, which isn't cheap. Performance isn't comparable either: the Z8000 Onyx is much faster than the 8085/88 machines.

Fortunately, we don't have to make any decisions just yet. It may be that the best policy is to skip all the 16-bit machines entirely and wait for a new generation of 32-bit monsters. Certainly if you're contemplating buying your first system, go ahead and get one: I still recommend the S-100 bus and Z80. You can upgrade to dual-density floppies and hard disks without *too* much risk, but if you want a system to *use* rather than play with, be conservative and leave systems development to the Tony Pietsches of this world. (Notice that if I get new systems in here, they'll be in addition to Zeke; him I don't touch.)

And stand by. Exciting things are happening in microland.

* * *

I like computer games. I'm fond of ZORK and the various Automated Simulation games, and now they've got a new one called Star Warrior that's guaranteed to use up more time than you thought you'd give it, especially if you're a fan of Heinlein's *Starship Trooper*. The game has a lot of the same appeal as that book. It's played in real time, and you jump about in space armor trying to wreak havoc on the dastardly enemy while avoiding death. And it's balanced: you usually get out alive, but just barely.

I'm a Star Warrior addict. The boys like ASI's Hellfire Warrior, which is an extension of their famous Temple of Aphsai. They also like ASI's Rescue at Rigel, which is Dungeons and Dragons in spacesuits. I expect I'd like them too, if I had time to play them.

However, I'm not enough of a masochist to play Scott Adams's Adventure International games. There are those who like Scott's games a lot. Certainly, they aren't easy. Unfortunately, for me at least, they're just too tough. For example, he's got one called Balrog Sampler (it also has the title Maces and Magic #1 on it), a vastly complex game requiring two 5¼-inch disk drives. Like Automated Simulation's Temple of Aphsai, when you enter the game it generates a random character for you, after which you buy weapons, armor, and the like, before setting out.

Unlike ASI's games, Adams's game gives you no choice. You *have* to accept the characters randomly generated for you and a scruffy lot they are. But don't worry—if you're lucky enough to get one who's strong as Superman and rich as Croesus, he's still going to get killed about the time you get interested in the game. *Everybody* gets killed in Adams's dungeon, and often unfairly. In Zork and Adventure there's some logic to the puzzles, but in Balrog various things pop up and kill you before you can run away. There's one room in his dungeon where you find an attendant and a wheel of fortune. If you don't play, the bouncer comes and kills you. If you do play, you lose.

There are other "puzzles" in Balrog, but all of them are inexplicable—at least to me—and I always get killed. So do the boys, and one of them is an experienced (and fanatical) Dungeons and Dragons player, so it isn't just my amateur status.

It wouldn't be so bad if you could just play, get killed, and start over, but since the game is in BASIC (with encrypted messages and all kinds of kludges to keep you from analyzing it) it takes forever to initialize, load, create a character, and go through the ritual of choosing weapons and armor, just so you can get killed two minutes later. The dungeon keeps score and the program alters itself after every expedition so that when next you play, the dungeon proudly displays the number of players who have entered and the number killed. Ours is up to about 25 for 25 now, and nobody in the neighborhood wants to see the game again.

Meanwhile, Workman & Associates continues to sell the original Crowther and Woods Adventure for CP/M systems (see my review, December 1980 BYTE, page 230), only now they've added a twist.

"Only with our Build-an-Adventure Kit can you truly build an Adventure," the Workman copy reads, and I guess that's nearly true. The "kit" consists of an Adventure data base and instructions for altering it or, if you like, starting over with everything new.

The data base contains a travel table (description of each room, where you can go from there, and what commands get you where); the vocabulary (five-letter or shorter words that the program will recognize); initial conditions for various rooms (light, water, oil, etc); messages, objects, including their initial location and whether or not they can be moved; treasures, which are a kind of object; and various other stuff.

It's amazing what you can do with it. For example, you can specify that to get from a room, say BEDQUILT, to another, say SWISS CHEESE, you will be successful 25% of the time if you go East, but always if you go Up, or that the travel will fail if you are not carrying the skull, or that it will fail if you *are* carrying the skull. You can automatically transfer from one room to an identical room (identical to the player), except all commands work backward in the second room, or there are extra objects and doors.

In the actual Adventure game this is done a lot: for example, there's a room with a live dragon standing on a carpet and another with a dead dragon lying near a carpet. Most players think it's the same room, since it's the same location, but in fact it's not. In the first room the carpet isn't real: it's part of the room description. If you tried to take it, the program would say "I see no carpet here" if the program wasn't instructed to issue messages about the dragon only. In the second room, the carpet is real, and so is the dead dragon, except that you can't "take dragon" successfully because he's an immovable object. Once you've killed the dragon, however, you can't get back to the room in which he's still alive.

Workman's implementation of Adventure includes a "wizard" routine that lets you move freely through the dungeon. He doesn't tell you how to use the routine unless you buy the "Build-an-Adventure Kit."

To build an adventure, you use a standard editor, such as Wordmaster, to alter the game data base (or create a new one), after which you invoke a BUILDER program. The program takes your logically ordered data base and makes a work file out of it, while simultaneously patching other chunks into the ADVENT.COM file that controls the game.

You can construct very complex dungeons and when you're done you have a game that recognizes vocabulary. You don't have to specify the permissible moves the way you must in BASIC adventure games.

I asked Workman how many of the people who buy the game intend to market adventures and he chuckled. He isn't sure, but he suspects that most copies are sold to people who bought Adventure and then couldn't solve the puzzles and mazes. "We give them the original Adventure data base with the Adventure Kit," Workman said. "That contains the Adventure map. We also tell them how to move through the dungeon by magic. I know that's why one guy bought the kit. He kept writing letters begging for the map. When we put out the kit, he bought the first copy."

Coming Up: In the next column I will continue to discuss languages, and I've also collected a raft of data bases I want to talk about. And I just finished letting Zeke do my taxes.... ■

References

Grogono, Peter. *Programming in Pascal* (revised edition). Reading MA: Addison-Wesley, 1980. $13.95.

Hughes, Joan K. *PL/I—Structured Programming*, second edition. New York: John Wiley & Sons, 1979.

Additional Information

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Book Reviews

Apple Pascal: A Hands-On Approach

Arthur Luehrmann and Herbert Peckham
McGraw-Hill Book Company, New York, 1981, 432 pages, softcover, $14.95

Reviewed by
Hartley G Lesser
3243 Oakes Dr
Hayward CA 94542

I knew very little about Pascal when I first sat down with this book. I had read a few magazine articles that described Pascal as a structured and understandable language, but my only programming experience was with BASIC and assembly language. I needed an introduction that assumed no prior knowledge, yet, at the same time, I wanted a book that didn't talk down to me. I'm happy to report that *Apple Pascal: A Hands-On Approach* is not only thorough and clear, but also treats the reader as the authors' equal. Although the authors begin at the most basic level, they seldom sound like lecturers. They teach as if they and the reader are working together on a series of intriguing experiments.

Written in a manner that will hold the interest of adults, this book also explains things clearly enough for children. My nine-year-old son worked through the first three chapters with apparent ease, although at a pace somewhat slower than my own. He learned to write simple Pascal programs and save them on disk, and moved on to the session on the graphics features of the Apple Pascal system. Judging from our experience, *Apple Pascal: A Hands-On Approach* will meet the needs of a wide variety of readers.

Although it focuses on Pascal, the book has more general applications. In addition to describing the mechanics of this one language, it explains sound programming techniques. If you have access to an Apple, then this book is an excellent way for you to learn the art of programming as well as the virtues of Pascal.

Hands On!

The title means what it says: this book's instructional method really requires you to get your hands on an Apple and work your way through. Mastering the material presented will require that you commit several hours each day to sessions with the Apple. The sessions present simple but interesting procedures that produce clear results—whether they be music, graphics, or text.

I resolved to spend two or three hours in front of my Apple each day for about six weeks. Sometimes events disrupted my schedule, but that only pointed out another of the book's strengths: the presentation of information in a natural sequence. With a minimum of rereading, I was usually able to pick up where I had left off. And at the end of six weeks of study, I had a firm grasp of the basics of Pascal.

The book is organized into work sessions rather than conventional chapters. The authors' method is to describe a project in general terms, and then try different approaches to see what works and what doesn't. The reader understands each point thoroughly as a result of running several slightly modified versions of the same program before achieving complete success.

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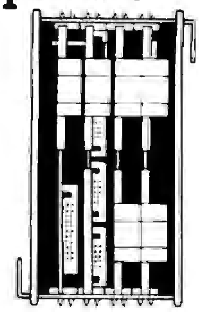

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The authors are careful to demonstrate the traps in the language system and how to cope with them. In fact, they instruct you to commit errors, then explain each error so that you really understand why some programs won't compile and run correctly. The explanations are all the more effective because they come after the demonstration.

Each new session begins with a brief summary of the previous session. After outlining the goals of the new session, the authors break it down into manageable sections. Each section treats a specific feature of Pascal—whether it be the command prompts, the use of variables, or the grammar rules that apply to the procedures under study. The authors end each session by presenting a brief summary and a series of thought-provoking questions and *problems*.

I strongly recommend that you answer the session-review questions and problems before you go on to the next session. The questions test your comprehension of the material presented, and although some questions are difficult, answering them lays a foundation for work to come. An appendix contains the answers, and the temptation to peek can be strong. Try to refrain from peeking until you've worked out your best answer to each question or problem. Then, of course, you can check your answers against those in the appendix.

Getting Started

Session 1, "Getting Started," tells the reader what he or she needs in order to work with the book: an Apple II or Apple II Plus computer with 48 K bytes of RAM (random-access read/write memory), a properly installed language system, a TV monitor or a TV receiver with RF (radio frequency) modulator, and a pair of game paddles. Only one disk drive is required, but instructions are included for using more than one. The text calls for Apple Pascal version 1.1, contained on two disks marked Apple0: and Apple3:. Both disks come with the purchase of the language system. The authors provide an appendix, however, for users of Apple Pascal version 1.0 that states every change that must be made in the text to accommodate the earlier version of the language. They stress the importance of keeping back-up copies and explain all of the 26 steps necessary to copy the distribution disks using two drives (Appendix B) and the even more numerous steps necessary when using a single drive (Appendix A).

Session 1 proceeds with instructions for "booting" Pascal and then guides the reader on a tour of the Pascal system that includes the command-prompt line, the file-prompt line, the filer's date-set command, the filer's "volume" feature (which displays a list of input and output devices that are "on-line"), and the filer's L command (which lists the directory of a disk). The session ends with an explanation of how to toggle from one half of the Pascal "page" to the other. Considering how much material the first session covered, I was surprised at how smoothly everything had gone.

The Pascal editor, including how to obtain the workspace needed to create programs and how to move programs into and out of memory and onto a disk, is explained in Session 2. Session 3 teaches the writing, running, and changing of programs. It was during this session that I first began to feel at ease with the Pascal language. In fact, the language seemed hospitable to my input.

Session 4 demonstrates the use of built-in procedures and taught me how to generate sound. I also learned how a function could provide input to a program, how a For loop works, and how to rename a disk or a file.

In Session 5, the importance of the distinction between local and global variables is emphasized, and the creation and calling of new procedures is explained.

Session 6 explains functions, comments brackets, and some new features of the editor. Session 7 presents more about graphics. I learned to use the "turtle," the creature that crawls across the screen drawing lines with pens of different colors—but I did encounter some difficulties in the process. I rushed through this session the first time. On the second time through, I was able to complete answers to all the questions and to write the programs requested by the authors. As a result of this experience, I recommend that you study at a moderate pace.

Session 8 covers branching statements, more graphics features, and the technique of obtaining user input for a running program. Session 9 tackles string variables and While loops, and Session 10 teaches number types and arithmetic. The authors deserve particular praise for this chapter; I loathe mathematics but found the material both interesting and effortless to learn.

Discovering the Scalars

Session 11 introduces scalar data types and sets. This session is strikingly successful in leading the reader to discover, by directed experiments, what a scalar data

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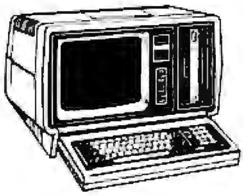

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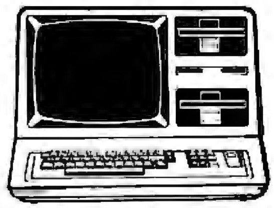

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type is. A few quotes (page 238) will give you an idea of the writing style:

> What is WHITE anyway? Well, what things could it be? First we note that WHITE appears in this program as a *parameter* that is being passed to the PENCOLOR procedure. That rules out the possibility of its being a reserved word, such as IF or FOR or WHILE or BEGIN, since reserved words never have *values*.
>
> The things that have values in Pascal are *variables*, *constants*, and *functions*. Perhaps WHITE is one of these things. . . . if WHITE is an integer or a real number or a character or a string, then WRITELN (WHITE) will tell us what its value is.
>
> Insert a semicolon after READLN and then the following new line:
>
> WRITELN (WHITE)
>
> Run the new version.
>
> Well, whatever WHITE is, it does not belong to one of these standard data types. The error message makes that plain. WHITE seems to have a value, but it is not a number, a character, or a string. Very mysterious.
>
> Here's another approach. . . .

And so on. The reader sees scalar data types and what they will and won't do. The authors let the reader infer much about scalars, and let the reader enjoy a real sense of discovery at every stage. The scalar data types are defined only after they have been revealed; by then, the reader feels like the Amerigo Vespucci of the scalars.

Session 12 uses the same experimental approach to introduce arrays and their uses. Session 13 provides a thorough introduction to records and file systems. Session 14, the last in the book, discusses recursion and its uses. The session ends with a dazzling color-graphics program.

In addition to the appendices already mentioned, there are the following: "Names, Reserved Words, and Built-in Names," "The Command Structure of Apple Pascal," "Size and Quantity Limits in Apple Pascal," and "ORD and CHR Values of ASCII Character Set." A list of the 500 compiler error messages follows a comprehensive index.

Every book has its flaws, but those I will name are minor. There are some instructional paragraphs that are long and tedious—more, I think, as a result of the book's design than of the authors' prose. A more liberal use of graphics would have broken the paragraphs into digestible chunks. The book also neglected two important commands: the one that clears the screen of text and the one that inserts tabs in output to the screen. I found these commands elsewhere, but the book should have mentioned them.

In summary, *Apple Pascal: A Hands-On Approach* is a fine introduction to a powerful and increasingly popular programming language. I can unhesitatingly recommend this book to any Apple owner, and I would jump at the chance to buy a sequel.■

Book Reviews

Threaded Interpretive Languages

by R G Loeliger
BYTE Books,
Peterborough NH
1981, 251 pages,
hardcover, $18.95

Reviewed by
A Richard Miller
61 Lake Shore Road
Natick MA 01760

Ron Loeliger's new book may well be the most important one in years for a growing number of FORTH programmers and enthusiasts. Although the book is called *Threaded Interpretive Languages*, the prospective reader should know that its subject is FORTH.

This book is well written and witty, but be warned that it is not trivial. It sets out to implement a Z80-based computer language, right before your eyes. The author calls his language ZIP: again, read FORTH.

For those who are able to discriminate among versions of this "newly arrived," high-level language (and/or assembler, and/or interpreter, and/or compiler, and/or operating system, and/or total computer environment, and/or seemingly whatever you wish), ZIP is a close approximation of microFORTH from FORTH, Inc. It is also generally similar to fig-FORTH, and to FORTH-79 systems including MMS-FORTH

It has become traditional to introduce FORTH with a series of initially baffling keyboard entries. One might lead off with some arithmetic, using FORTH's Reverse Polish Notation (eg: the FORTH phrase { 5 5 * . }) instead of BASIC's more familiar ("PRINT 5*5. Next, one might demonstrate FORTH's ability to add new words to its instruction set, adding a new word to do a given job (eg: the FORTH phrase { : SQUARE DUP * . ; } compiles a new instruction named SQUARE, which then might be executed as { 5 SQUARE } to do the same thing as the above examples). Soon, one is switching number bases with HEX, and DECIMAL, switching dictionary vocabularies with EDITOR , ASSEMBLER and FORTH , and eventually creating whole new types of defining words with <BUILDS (79-STANDARD now calls it CREATE) and DOES> .

This traditional approach presumes that one must have many hours of low-level experience with the language before considering why FORTH works the way it does. As with BASIC, most users never get around to learning how FORTH literally threads its way through the internals of the computer to gain its ends. But its unique internal design makes FORTH what it is and *Threaded Interpretive Languages* starts with internal design and stays there for most of its pages. It assumes no knowledge of FORTH but does demand more than a beginner's familiarity with computers. To practice routine FORTH operations, get another book, a lot of sample FORTH source code, an adequate FORTH system to run on your computer, and some learning projects of your own. To learn FORTH inside out, however, buy this book!

Any good FORTH system is very compact and very fast. For example, on the TRS-80 Model I or III, MMS-FORTH is about 20 times faster than Level II BASIC. Thus, many programmers do all FORTH programming in high-level FORTH. But FORTH includes a resident assembler and, where extra speed helps, it is at your command. I like the author's unbiased way of balancing the trade-off between the ease and elegance of high-level FORTH and the "brute force" capabilities of assembly language.

The publisher deserves praise for treating this book as just that—a book. Up to now, most FORTH books have been indifferently printed and looseleaf bound. In contrast, *Threaded Interpretive Languages* is a solid little hardcover book, professionally produced and with a touch of class.

I do have some minor criticisms. The book uses black squares to represent the space characters within the code. Although it is useful to indicate the spaces (rather than to assume them), these large black squares overwhelm the eye and distract the mind. I recommend the use of unobtrusive open squares for the book's next edition. In a similar vein, the input lines are printed with proportional spacing between the characters, in contrast to the "typewriter-spaced" uniformity of a video terminal. Although this "typeset" style may appear more attractive, it is less faithful to the original material and is, I believe, misapplied here.

It is unfortunate that the author chose to call the language ZIP instead of FORTH, as that further complicates the issue. I imagine that, when he wrote this material, he wished to avoid any conflict with FORTH, Inc, which holds the rights to its name. However, in the last few years, FORTH, Inc has been gracious enough to encourage systems houses to produce versions with several variants on the name. His caution, therefore, appears unnecessary and—given the title of this important book—somewhat misleading.

It may also be misleading to say that the book implements a computer language. It does, but the author correctly warns that the implementation will require some work by the reader. It will also require some decisions that will affect certain trade-offs, lots of ability, time, patience, and a very good idea of what you intend to accomplish. A few expert programmers will follow his pattern to create elegant and streamlined FORTH. Others may concoct unfortunate approximations of good systems.

Most readers will do neither, but reading this development of a FORTH system will enable them to appreciate the several complete FORTH systems now available for microcomputers.

As a good book on music theory stimulates musicians, I believe this text will serve most effectively as a marvelous insight for those working with existing—and debugged—FORTH systems. In other words, do not study music theory without practicing on a musical instrument. And, if at all possible, do not design an instrument without first playing on another.

FORTH has existed only for a decade. It has thousands of users, but it was invisible to the general microcomputer community until the special FORTH issue of BYTE (August 1980). In this reviewer's opinion, *Threaded Interpretive Languages* is the first book of excellent quality among the few written about the language. ■

Software Received

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.

Apple

Auto-Modem, a telecommunication utility program for the Apple II. Floppy disk, $39.95. Computer Station, 11610 Page Service Dr, St Louis MO 63141.

Castle Wolfenstein, a real-time graphics adventure program for the Apple II and Apple II Plus. Floppy disk, $29.95. Muse Software, 330 N Charles St, Baltimore MD 21201.

Enhanced Centronics 739 Graphics Software, a utility program that prints high-resolution graphics for the Apple II. Floppy disk, $44.95. Computer Station (see address above).

Enhanced Graphics Software, for the Epson MX-80. A utility program that prints high-resolution graphics for the Apple II. Floppy disk, $44.95. Computer Station (see address above).

Enhanced Graphics Software, for the NEC Spinwriter (5510/5520). A utility program that prints high-resolution graphics for the Apple II. Floppy disk, $44.95. Computer Station (see address above).

Falcons, a graphics arcade game for the Apple II and III. Floppy disk, $29.95. Piccadilly Software Inc, 89 Summit Ave, Summit NJ 07901.

MACRO-SCED 2.1, a cursor-oriented screen editor for the Apple II. Floppy disk, $49.95. Computer Station (see address above).

Micro-DSS/Finance, a financial planning and analysis package for the Apple II Plus. Floppy disk, $1500. Addison-Wesley Publishing, Jacob Way, Reading MA 01867.

NET-WORKS, a bulletin-board and information-service system for the Apple II. Floppy disk, $124.95. Computer Station (see address above).

P-LISP 2.0, an implementation of the interpretive language LISP for the Apple II. Floppy disk, $99.95. Pegasys Systems Inc, 4005 Chestnut St, Philadelphia PA 19104.

Powertext, a word-processing program for the Apple II. Floppy disk, $199. Beaman Porter Inc, Pleasant Ridge Rd, Harrison NY 10528.

Professional Easywriter Version 4, a word-processing program for the Apple II. Floppy disk, $250. Information Unlimited Software, 281 Arlington Ave, Berkeley CA 94707.

Ultra Hi-Res Graphics, a utility program that plots as much as a full page of output for the Paper Tiger 460G to 560G series printers and the Apple II. Floppy disk, $49.95. Computer Station (see address above).

Word Handler, a word processor that does not require hardware modifications for the Apple II. Floppy disk, $189. Silicon Valley Software, 652 Bair Island Rd, Redwood CA 94065.

Zork: The Great Underground Empire, Part I, Adventure-type game for the Apple II. Floppy disk, $39.95. Personal Software, 1330 Bordeaux Dr, Sunnyvale CA 94086.

Commodore VIC

Biorhythm Compatibility, a program that compares biorhythm charts for the Commodore VIC-20. Cassette, $14.95. Commodore, 950 Rittenhouse Rd, Norristown PA 19403.

Space Math, a utility program that solves basic mathematical problems for the Commodore VIC-20. Cassette, $14.95. Commodore (see address above).

TI 99/4

Invoice Management, a utility program that maintains a customer-invoice file for the TI-99/4. Floppy disk, $69.95. Texas Instruments Inc, Dallas TX 75265.

Saturday Night Bingo, a board game for the TI-99/4. Floppy disk, $29.95. Texas Instruments Inc (see address above).

Speak & Spell Program, emulates a TI Speak & Spell for the TI-99/4. Floppy disk, $29.95. Texas Instruments Inc (see address above).

Structural Engineering Library, five programs that solve engineering problems for the TI-99/4. Floppy disk, $29.95. Texas Instruments Inc (see address above).

Teach Yourself Extended BASIC, a self-help guide to TI Extended BASIC for the TI-99/4. Floppy disk, $24.95. Texas Instruments Inc (see address above).

TRS-80

B17 Disk/Bas, a utility program that saves and loads disk files to and from cassette tapes for the TRS-80 Model I. Cassette, $14.95. ABS Suppliers, POB 8297, Ann Arbor MI 48107.

CC Writer, a word-processing program for the TRS-80 Color Computer. Cassette, $30. Transformation Technologies, 194 Lockwood Ln, Bloomingdale IL 60108.

DC Circuit Analysis, a program that solves DC circuits for the TRS-80 Model I. Cassette, $11.95. Computer Heroes, 1961 Dunn Rd, East Liverpool OH 43920.

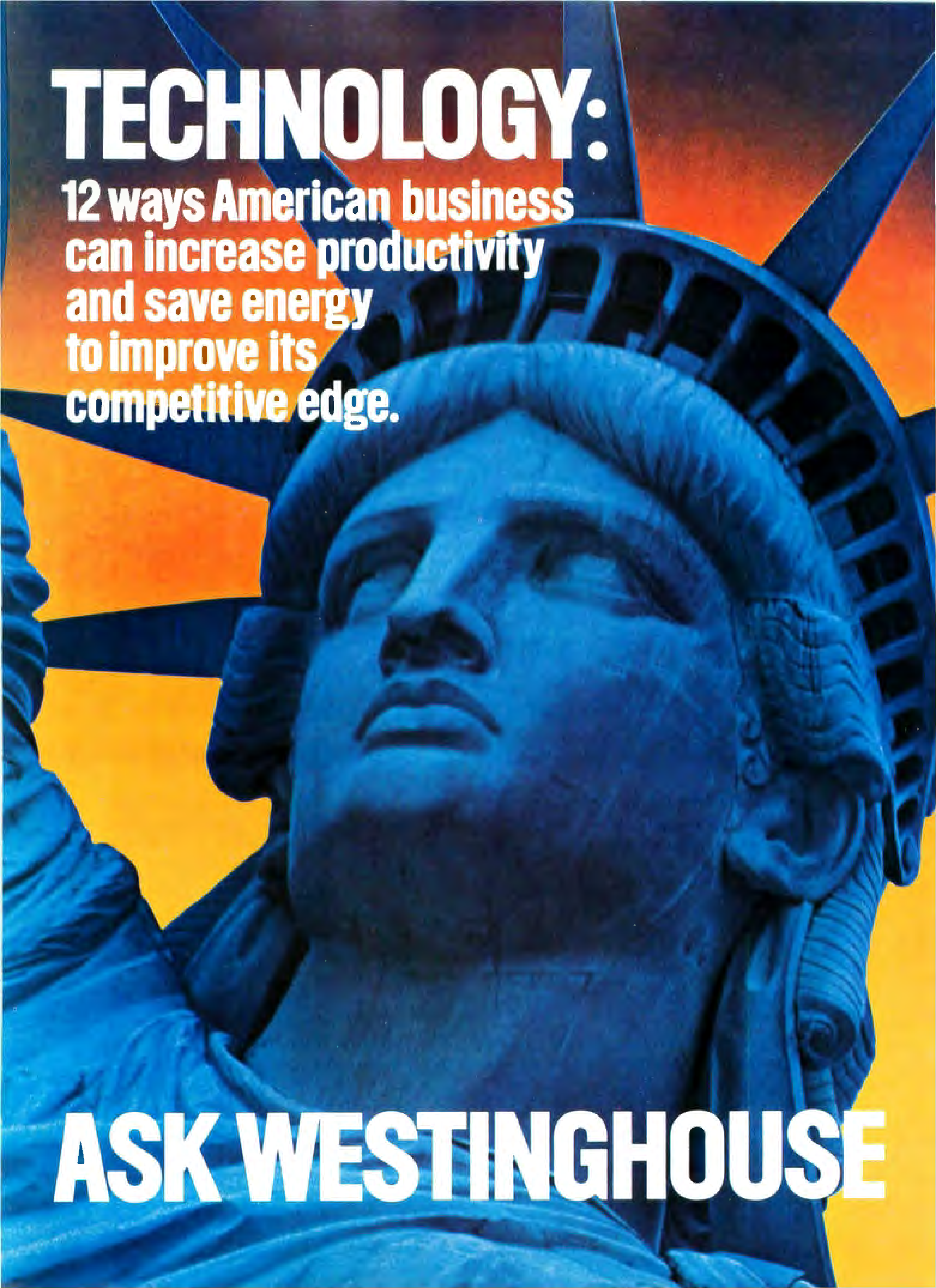
KWIK Cassette Operating System, for the TRS-80 Model I. Cassette, $24. KWIK Software, POB 328, Bolivar MO 65613.

Maxi Manager A.3, a database management system for the TRS-80 Model I. Floppy disk, $99.95. Adventure International, POB 3435, Longwood FL 32750.

New DOS/80 Version 2.0, a disk operating system for the TRS-80 Model I. Floppy disk, $149. Apparat Inc, 4401 S Tamarac Parkway, Denver CO 80237.

Stock Scoreboard, computes investment return and updates holdings for the TRS-80 Model I and III. Cassette, $15. Gary L Gilbert, 975 D Elgin, San Lorenzo CA 94580.

Wordsmith, a word processor for disk systems, for the TRS-80 Model I. Cassette, $14.95. ABS Suppliers (see address above).■


TECHNOLOGY:
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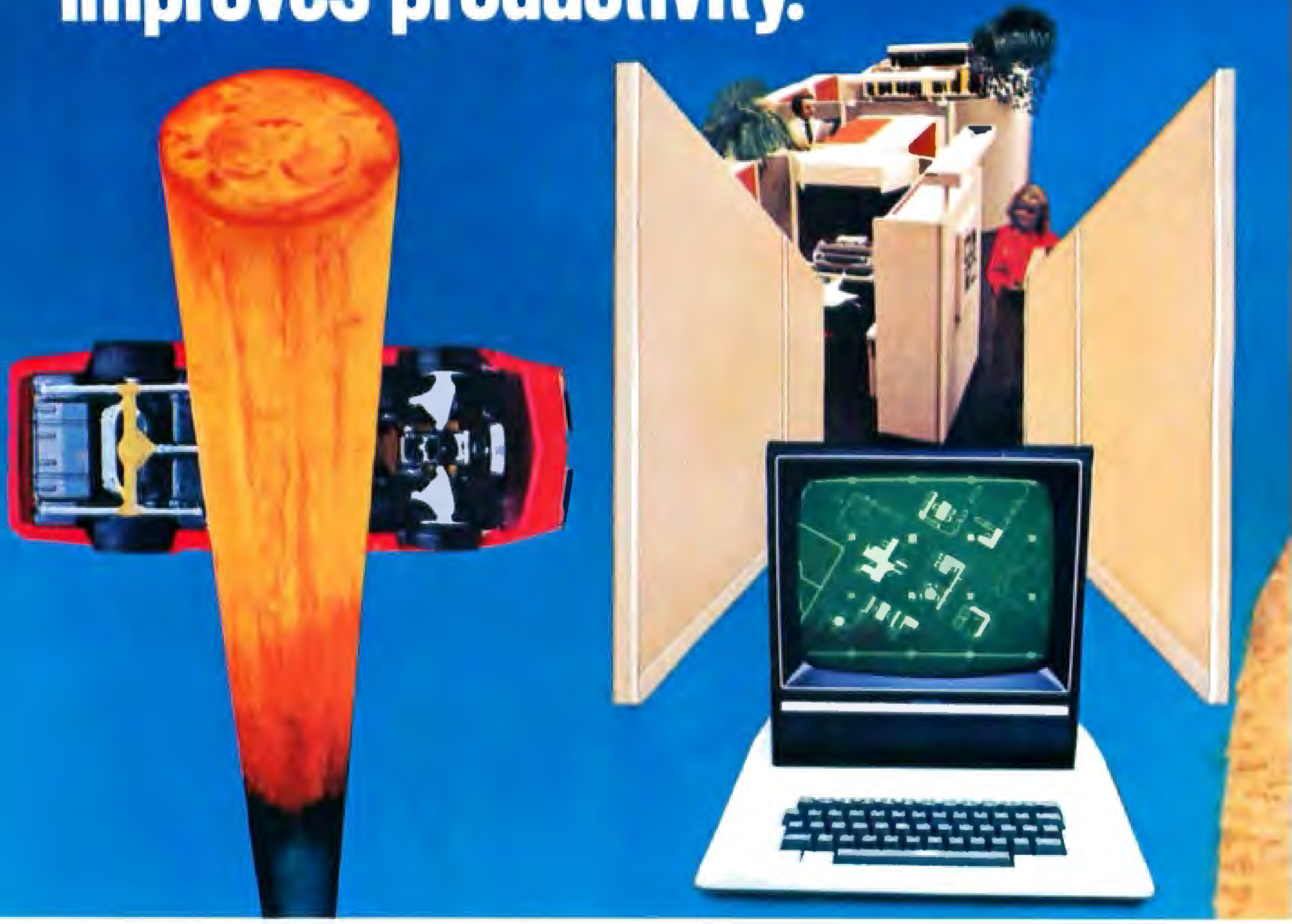


Precision Heating for Metal Processing increased productivity by 300 percent and cut energy costs by 50 percent for a forging facility.

The Westinghouse induction heating system is so much faster than any type of surface heating, it enables the forge to produce parts at three times the old rate. That's because the controlled electric current flow within the bar stock heats to the precise depth required.

Such controlled heating from within significantly reduces the energy waste that accompanies surface heating. It also means an improved environment for employes involved with forging, forming, rolling, heat treating or curing of coatings.

Office productivity increased 6 percent when a Westinghouse "Open Office" System was installed by a major Eastern bank.

"Open offices" improved communications, provided efficient work stations and lowered noise levels for the bank's programmers and analysts. Productivity increased almost overnight.

Today, white collar employes represent half of the American work force, but white collar productivity has increased only 0.4 percent per year in the last five years. Installing "open offices" by Westinghouse can improve those figures.

Microprocessor-based production control increased productivity 300 percent for an agri-business.

A Westinghouse Numa-Logic™ PC-700 programmable controller system replaced manual batching. Now a single 8-hour shift can mix 720 tons of 30 different types of feed requiring 41 separate ingredients. With only a 1 percent weight error in a given ingredient.

Before Numa-Logic, the same output required two 12-hour shifts, and there was a 20 percent weight error.

The Westinghouse Numa-Logic can increase productivity in a wide variety of process and manufacturing operations.

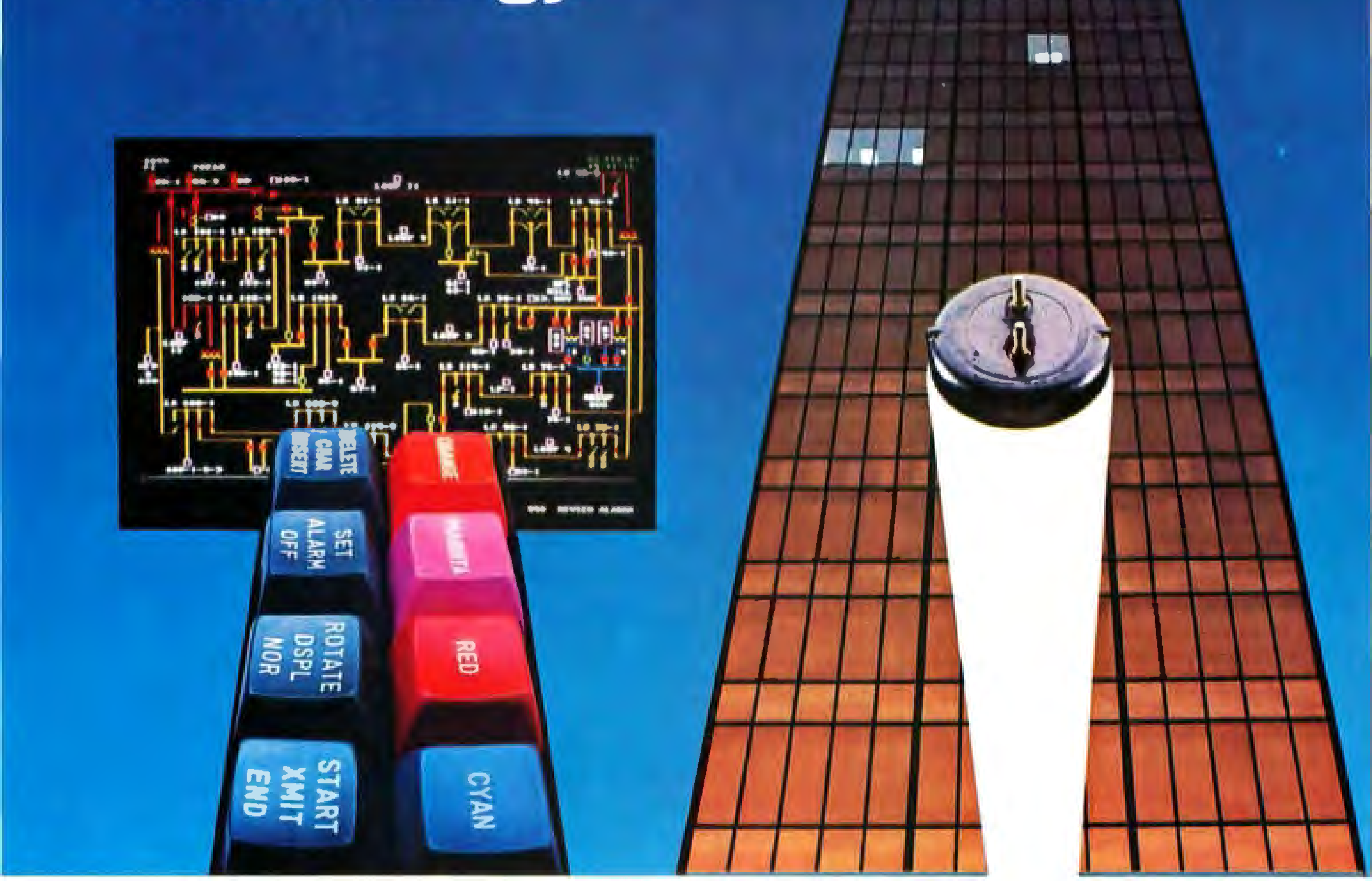
Ultrasonic Cleaning and Degreasing increased productivity by over 900 percent for a manufacturer of iron molds.

Instead of 1,300 man-hours and $21,500 to clean 100,000 units, now it takes 133 man-hours and slightly over $2,100.

Westinghouse Ultrasonic Cleaning does a faster, more thorough cleaning job than any other method. Using less harsh chemicals and no elbow grease, high intensity sound waves implode small vapor bubbles that blast off dirt and residue.

If cleaning has been your productivity bottleneck, ultrasonics could be the answer.

Westinghouse technology saves energy.



Energy Management will save over $800,000 per year in fuel consumption and labor costs for a 600-acre, 150-building chemical plant.

A Westinghouse Industrial Energy Management System replaced the plant's slower, traditional ways of monitoring and adjusting energy generation and use.

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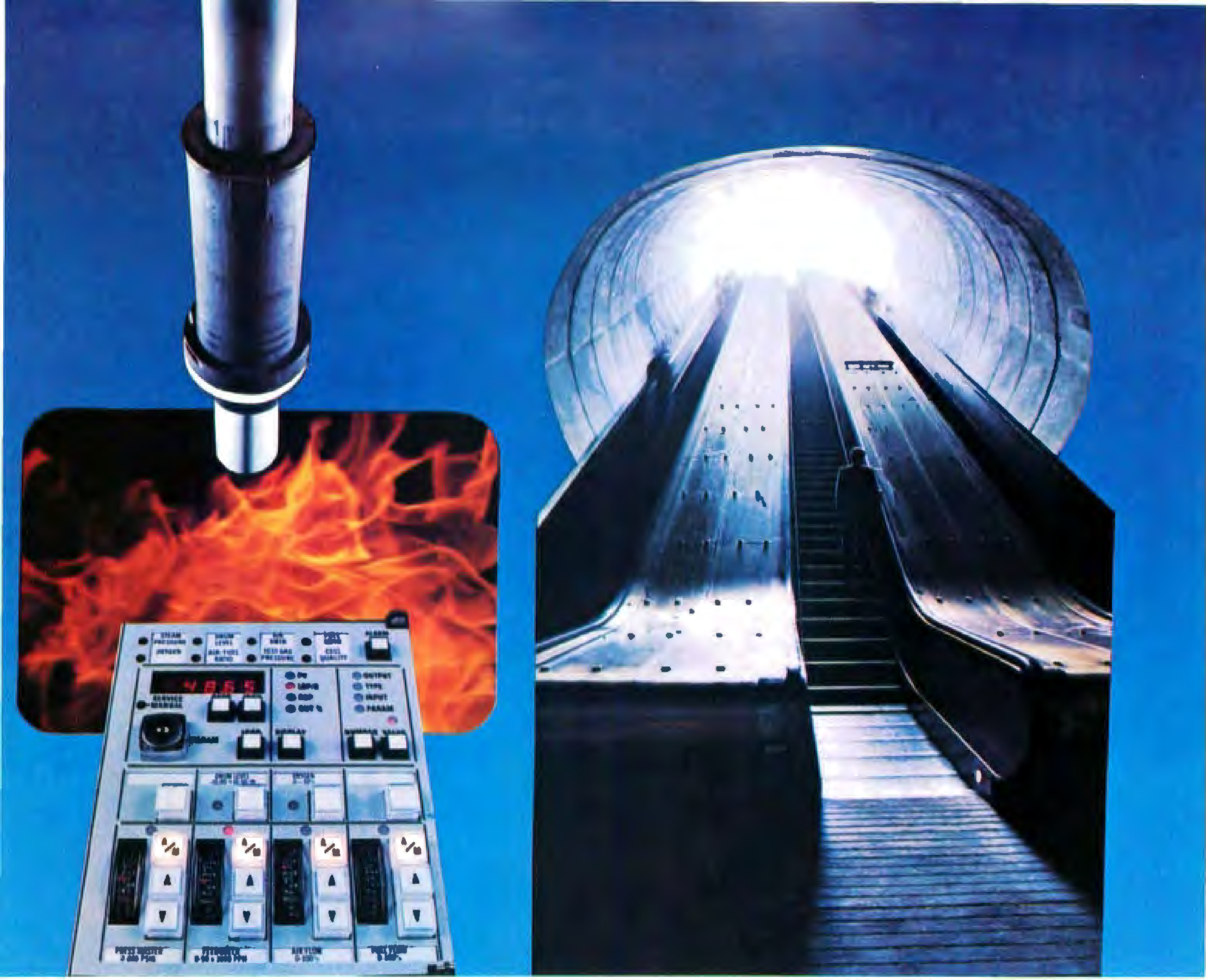
The bank has since installed Ultralumes in two other facilities. And is saving an additional $84,000 annually as a result.



Combustion Control has cut the fuel bill of an Eastern chemical company 15 percent, saving it $75,000 per year.

The company installed a Westinghouse fully automatic boiler system on one of its four boilers.

Combining a probe-type oxygen analyzer with a microprocessor-based oxygen trim controller, the system optimized fuel consumption, increased safety, and decreased excess oxygen by 8 percent.

It has been so impressive that the company has ordered similar equipment for its three other boilers.

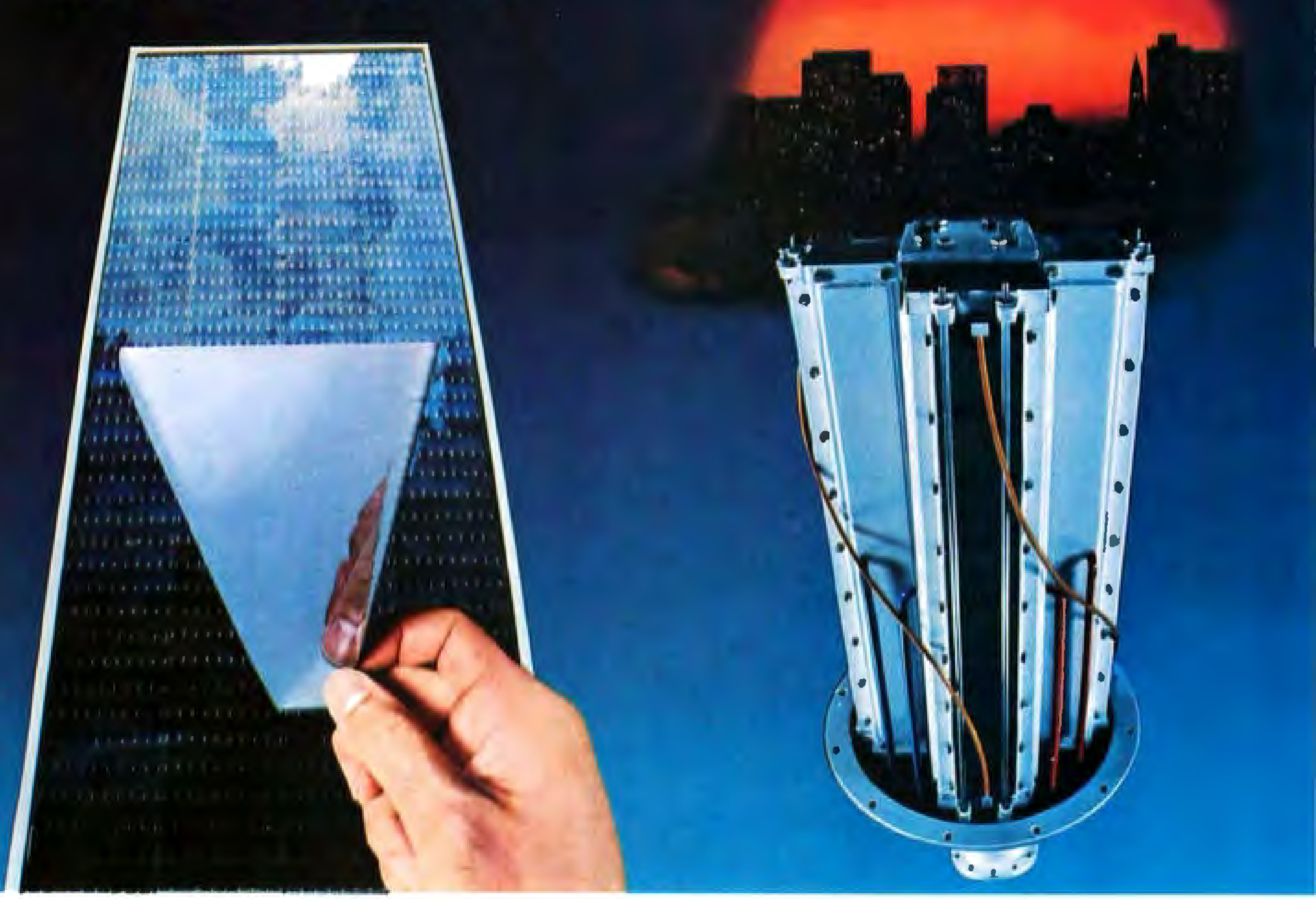
Modular escalators will save over $150,000 per year in energy costs for the mass transit system of a major East Coast city.

The 354 Westinghouse Moduline 100* escalators used there save 30 percent of energy costs when going "up," 60 percent when going "down" compared to the conventional type.

These advanced Westinghouse escalators can be connected in modular sections, giving architects a design freedom they never had before. These escalators can skip a floor, span vertical rises of 100 feet or more, and provide a nonstop 10-story ride.

That's right, 10 stories.

Westinghouse technology for the future.



Electricity from sunlight is one step closer to economic reality.

The unique Westinghouse Dendritic Web process promises to significantly reduce the cost of manufacturing photovoltaic cells.

It produces long, thin, continuous strips of single crystal silicon, the main component of solar cells. The costly and wasteful slicing of silicon blocks has been eliminated.

Modules like the one pictured behind the dendritic strip above can produce up to 16 watts per square foot. Now, Westinghouse is working toward automated production facilities. And we've designed and installed systems for residential application.

Fuel Cells promise to be a highly efficient, compact, nonpolluting source of electric power.

Westinghouse is developing two types of fuel cells.

One is a phosphoric acid fuel cell targeted for the mid 80's. It converts any hydrogen-rich fuel such as synthetic gas from coal directly into electricity. It's environmentally benign, the only by-products are carbon dioxide, heat and pure water.

The other type is a solid oxide design. It's even more compact and more fuel efficient than the phosphoric acid fuel cell. With an 1800°F operating temperature, it's ideal for industrial cogeneration. It should be ready for use by the mid 90's.

High Power Battery technology may soon give commercial vehicles such as delivery vans a 100-mile cruising range, take only 4 to 6 hours to recharge, and last 100,000 miles.

Westinghouse is developing a high power nickel-iron battery that offers the best combination of high energy density, long life cycle, longer time between charges and competitive life cycle costs.

Smaller and lighter than older types of batteries, the new Westinghouse nickel-iron battery could also replace fossil fuels as the power source for industrial forklifts, mining machines, and airplane tow trucks.

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the Netherlands	74.8%
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Germany	59.9%
Italy	59.0%
United Kingdom	25.5%

Source: Based on most recent data from the Bureau of Labor Statistics, United States Department of Labor, June, 1981

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Computer Club Rides In Central Texas

The Computer Club of San Marcos has been formed to promote personal computing in central Texas. Correspondence from other clubs is invited, and all can attend meetings. For information, contact January Smith, POB 381, Martindale TX 78655, (512) 357-6762.

Packet-Switching Network

VADCG (Vancouver Amateur Digital Communications Group) is devoted to creating a packet-switching network via amateur radio. It is experimenting with high-speed protocol transmissions, and efforts are underway to connect a smart terminal node-controller board that interfaces any parallel or asynchronous serial device to the network. Other projects include an S-100 card to provide the centralized station node network control and a 1200-bit-per-second modem for connection to VHF (very-high frequency) transceivers. Some public-domain software is available and more is being developed. Newsletter subscriptons are $10 from VADCG, 818 Rondeau St, Coquitlam, British Columbia, V3J 5Z3, Canada.

Computer Graphics Software News

The Computer Graphics Software News reviews computer programs in the public and industrial domain that deal with computer-generated graphics. Areas of interest are computer-aided design and manufacturing, animation, business graphics, image processing, and petrophysical-related software. The subscription rate is $50 a year (six issues). Contact *The Computer Graphics Software News*, 5857 S Gessner, Suite 401, Houston TX 77036, (713) 975-8509.

PET Users Meet In Golden State

The Southern California PET Users Group meets the first Tuesday of each month at 7 PM at the Data Equipment Supply Corporation, 8315 Firestone Blvd, Downey, California. For more details, call Lyle Phillips at (213) 693-3175.

CCAN

Construction Computer Applications Newsletter-CCAN is a monthly publication from the Construction Industry Press. It has information and reviews on computer products designed exclusively for the construction industry. A one-year subscription to the *Construction Computer Applications Newsletter-CCAN* costs $48. Contact the Construction Industry Press, 1105-F Spring St, Silver Spring MD 20910, (301) 589-4884.

Mail-Order Software Library

ESL (Educational Software Library) is a nonprofit, mail-order library of educational programs for the TRS-80 Models I and III. Members receive a bimonthly newsletter that describes current selections, which range from preschool to high school level.

A one-year membership costs $20 and entitles you to the newsletter, two educational tapes, the opportunity to borrow programs for two-week periods at $2 per tape, and the chance to purchase software at discount prices. Contact ESL Inc, 262 Park Ln, King of Prussia PA 19406.

Microsrv Newsletter

The *Microsrv* newsletter has short articles, technical tips, news, and programming help. It is primarily for Apple users, but much of the information can be applied to any system. For details on subscriptions or submitting editorial material, contact *Microsrv*, 20th Century Business Systems, 324 W 145th Pl, Riverdale IL 60627, (312) 841-3400.

Librarians and Microcomputers

The University of Arizona Graduate Library School has announced the availability of the *Small Computers in Libraries Newsletter*. The newsletter acts as a clearinghouse for the sharing of information on microcomputers in libraries. It offers glossaries, short tutorials, and reviews of programs and books pertinent to the subject. Subscriptions start at $20 from the Graduate Library School, Attn: SCIL, University of Arizona, 1515 E First St, Tucson AZ 85719, (602) 626-3565.

New TRS-80 Group In North Carolina

The Greensboro TRS-80 Group is a recently formed club that wants to learn all it can about TRS-80 equipment. Contact David K Bodman, POB 7785, Greensboro NC 27407, (919) 855-9155.

Sun Shines On New CBBS

A new CBBS (computerized bulletin-board system) has gone on line in Orlando, Florida. The system is positioned to service central Florida, and licenses are available for other areas. No particular subject dominates the board. The 24-hour telephone number is (305) 830-8166.

National Apple Newsletter

Owners and users of Apple II and II Plus computers now have a club publication devoted to their needs. *The National Apple Newsletter* will print anything members demand: Pascal programs, home control, computerized alarm systems, and other practical applications. For more information, contact Scott Summer, 27 Leicester Way, Pawtucket RI 02860.■

Event Queue

November 1981

November-December

Courses from Datapro, various sites throughout the US. Datapro Inc's educational program features seminars and one-day management briefings on a wide range of subjects. Among the topics to be presented are "Structured Systems Analysis," "Introduction to Micro/Personal Computers," "Local Networks," "Evaluating and Selecting Computer Software Packages," and "BASIC: Introduction to Computer Programming."

Seminar enrollment fees are $595 for Datapro subscribers and $645 for nonsubscribers. The management briefings cost $360 and $395, respectively. Contact Datapro Research Corporation, 1805 Underwood Blvd, Delran NJ 08075, (800) 257-9406; in New Jersey (609) 764-0100.

November-December

The Master Method of Selling Small Business Systems, various sites throughout the US. MWL Inc is offering a series of one-day seminars for manufacturers of small-business systems and software vendors. The price for a seminar is $135. Contact the Seminar Coordinator, MWL Inc, 32038 Watergate Ct, Westlake Village CA 91361, (213) 889-2607.

November-March 1982

Two-Day Seminars for Professional Development, Worcester Polytechnic Institute, Worcester MA. Courses on the fundamentals of data processing, data communications, and microprocessors are being offered by Worcester Polytechnic Institute at its campus and at selected locations in the Boston metropolitan area. The fee is $445. Contact Ms Ginny Bazarian, c/o the Office of Continuing Education, Worcester Polytechnic Institute, Worcester MA 01609, (617) 793-5517.

November 12-14

Accounting and Information Systems Expo '81, MGM Grand Hotel, Reno NV. This exposition is geared toward accounting experts and information-systems analysts, designers, and managers. The emphasis will be on technological advances in the field and ways in which these advances can improve efficiency and effectiveness. For more information, contact Leanne Stone, c/o the University of Nevada-Reno, Division of Continuing Education, College Inn, Reno NV 89557, (702) 784-4046.

November 13

The Impact of New Technologies on Information Service Environments, Battelle Columbus Laboratories, Columbus OH. The Ohio chapters of ASIS (American Society for Information Science) are sponsoring this one-day seminar. Speakers and a panel will examine the impact of electronic publishing, videodiscs, and personal computers on libraries and corporate information centers. Registration fees are $40 for ASIS members, $50 for nonmembers, and $10 for students. For details, contact Katherine Frohmberg, Oberlin College Library, Oberlin OH 44074, (216) 775-8285.

November 13-15

The Los Angeles Computer Showcase Expo, Convention Center, Los Angeles CA. The Computer Showcase is designed to place vendors and their intermediaries in touch with small-computer-system users. For details, contact the Interface Group, 160 Speen St, Framingham MA 01701, (800) 225-4620; in Massachusetts (617) 879-4502.

November 16-17

Computer-Aided Graphics Systems: Design and Drafting Tools, Marriott Pavilion Hotel, St Louis MO. This course has been designed for middle- and upper-level administrators who are responsible for planning, evaluating, selecting, acquiring, and implementing computer-graphics systems for industrial design and drafting purposes. The course fee is $295.

For technical information, contact Ralph E Lee, Mathematics-Computer Science Building, University of Missouri-Rolla, Rolla MO 65401, (314) 341-4491. Course or registration information can be obtained from Martha K Fort, Arts & Sciences Continuing Education, 105A Humanities-Social Sciences Building, University of Missouri-Rolla, (314) 341-4943.

November 16-19

The 1981 Electronics and Aerospace Systems Conference (EASCON '81), Washington Hilton Hotel, Washington DC. The theme of this conference is "Government-Industry Interchange." The exhibition will include displays from many electronics and aerospace companies. For details, contact EASCON '81, 608 H St, SW, Washington DC 20024, (202) 347-7088.

November 19-21

Business and Personal Computer Sales-Expo '81, Philadelphia Civic Center, Philadelphia PA. The Sales-Expo is aimed at a wide range of computer users. The show features exhibits of microcomputers, business supplies, peripherals, and software. For more information, contact Produx 2000 Inc, POB 2000, Bala Cynwyd PA 19004, (215) 457-2300.

November 20-22

Symposium on Small Computers in the Arts, Philadelphia PA. The Symposium on Small Computers in the Arts (formerly the Personal Computer Arts Festival) is being held to bring together individuals interested in using small computers in the audio and visual arts. The Symposium will offer a range of presentations from introductory tutorials to sessions on advanced techniques. Workshops, exhibits, and demonstrations are also planned.

Complementing the Symposium will be the Fourth Annual Computer Music Concert. Contact the Symposium at POB 1954, Philadelphia PA 19105, (215) 243-8109.

November 22-24
Data-Telecommunications Expo, Rhein-Main-Halle, Wiesbaden, West Germany. Exhibits of equipment and systems for applications in commerce and industry plus a conference program complementing these subjects will be presented. Details are available from Kiver Communications S.A., UK Branch Office, 171/185 Ewell Rd, Surbiton, Surrey, KT6 6AX, England.

December 1981

December 1-3
Legal Info, Shoreham Hotel, Washington DC. Automating legal-information systems is the subject of this conference and exposition. Attorneys wishing to use computers in their work are invited to attend. Contact Legal Info, 1730 N Lynn St, Suite 400, Arlington VA 22209, (703) 521-6209.

December 1-4
Computer-Network Design and Protocols, Washington DC. Integrated Computer Systems (ICS) will be presenting a course on fundamentals in computer communication-network concepts, technology, and implementation. Emphasis is on the practical aspects of network design, interfacing, protocols, and packet switching. For a schedule of times and locations, contact Ruth Dordick, c/o Integrated Computer Systems, 3304 Pico Blvd, POB 5339, Santa Monica CA 90405, (800) 421-8166; in California (800) 352-8251.

December 2-3
Introductory Seminar on UNIX, Key Bridge Marriott Hotel, Arlington VA. Human Computing Resources Corporation is offering this two-day seminar on the use of UNIX for programmers, analysts, and anyone needing to know about this operating system. For details, contact the Course Coordinator, c/o Human Computing Resources, 10 St Mary St, Toronto, Ontario, M4Y 1P9, Canada, (416) 922-1937.

December 3
California Computer Show, Hyatt Hotel, Palo Alto CA. For details and a schedule of upcoming events, contact the Show Administrator, c/o Norm De Nardi Enterprises, 95 Main St, Los Altos CA 94022, (415) 941-8440.

December 3-4
Computer Graphics: Microprocessor/Personal Computer Systems, Marriott Pavilion Hotel, St Louis MO. This course has been designed for managers, educators, and graphics users responsible for evaluating and acquiring microcomputers and graphics systems. The course fee is $195.

For technical information, contact Ralph Lee, Mathematics-Computer Science Building, University of Missouri-Rolla, Rolla MO 65401, (314) 341-4491. Course or registration information can be obtained from Martha K Fort, Arts & Sciences Continuing Education, 105A Humanities-Social Science Building, University of Missouri-Rolla, (314) 341-4943.

December 8

Computer Networking Symposium/National Bureau of Standards, Gaithersburg MD. This conference is being sponsored by National Bureau of Standards and the Institute of Electrical and Electronics Engineers. Contact Robert Toense, B226 Technology Building, National Bureau of Standards, Washington DC 20234, (301) 921-3516.

December 9-11

The 1981 Winter Simulation Conference (WSC 81), Peachtree Plaza, Atlanta GA. WSC 81 will feature papers, panel discussions, and tutorials on discrete and combined simulation and modeling. The conference will be organized into tutorial, methodology, and application sessions. For information, contact John Carson, WSC 81 Registration Chairman, School of Industrial and Systems Engineering, Georgia Institute of Technology, Atlanta GA 30332, (404) 894-2308.

December 15-19

Gulf Computer Exhibition, Dubai International Trade Centre, Dubai, United Arab Emirates. IBM, NCR, Apple, Honeywell, Philips, Wang, Hewlett-Packard, Data General, and other well-known manufacturers will be represented at this first exhibition of computer equipment in Dubai. The scope of the show takes in systems ranging from microcomputers to mainframes. Details are available from the Trade Centre Management Company, POB 9292, Dubai, United Arab Emirates, Telex 47474 DITC EM, and from Diana Clifton Sewell, International Office, Seymour House, 17 Waterloo Pl, London, SE1Y 4AR, England.

December 16-18

The Twentieth IEEE Conference on Decision and Control (CDC), Vacation Village Hotel, San Diego CA. The CDC is the annual meeting of the IEEE (Institute of Electrical and Electronics Engineers) Control Systems Society. It is held in cooperation with the Society for Industrial and Applied Mathematics. The conference will include contributed and invited sessions plus tutorials and presentations on all aspects of the theory and applications of systems involving decision, control, and adaptation. Other topics of interest include linear and nonlinear system theory, stability theory, large-scale system theory and decentralized control, estimation, identification, signal processing and stochastic control, and control systems. For more information, contact the Institute of Electrical and Electronics Engineers Inc, 445 Hoes Ln, Piscataway NJ 08854.

December 28-30

Computer Modeling of Linguistic Theory, Grand Hyatt Hotel, New York NY. The ACL (Association for Computational Linguistics) is sponsoring three sessions on computer modeling of linguistic theory in conjunction with the annual meeting of the Linguistic Society of America. New models for grammars and new strategies for parsing will be the areas of most attention. Readings of contributed papers will also be featured. Contact Stan Petrick, IBM Research Center, POB 218, Yorktown Heights NY 10598.

January 1982

January-April
Fundamentals of Data Processing for Administrative Assistants and Office Support Staff, various sites throughout the US. The American Management Association (AMA) has designed this three-day course for secretaries, assistants, supervisors, and other personnel desiring to learn the fundamentals of data processing and its use in offices. Computer hardware and software, programming languages, and technology will be covered. The team fee for AMA members is $470 per individual and $550 for nonmembers. Individual fees are $550 and $630, respectively. For a schedule of dates and locations, contact the AMA, 135 W 50th St, New York NY 10020, (212) 586-8100.

January 6-8
The Fifteenth Annual Hawaii International Conference on Systems Sciences (HICSS-15), Honolulu HI. This conference is cosponsored by the University of Hawaii and the University of Southwestern Louisiana in cooperation with the Association for Computing Machinery (ACM). HICSS-15 is intended for medical information-processing researchers and practitioners. Among the topics to be covered are diagnosis by computer, computer-based medical instrumentation, computers and the handicapped, and the use of computers in individual and group practices, medical laboratories, and hospitals. Contact Dr Bruce D Shriver

and Dr Terry M Walker, c/o HICSS-15 Medical Information Processing, University of Southwestern Louisiana, POB 44330, Lafayette LA 70504.

January 7-10
The 1982 Winter Consumer Electronics Show (CES), Las Vegas Convention Center, Hilton Hotel, and the Jockey Club, Las Vegas NV. Conferences, workshops, seminars, sales meetings, press events, and exhibits of audio and video equipment, computers, telephones, and other consumer items highlight this show. For details, contact Consumer Electronic Shows, Two Illinois Center, Suite 1607, 233 N Michigan, Chicago IL 60601, (312) 861-1040.

January 12-15
Communication Networks Conference and Exposition, Georgia World Congress Center, Atlanta GA. The Communication Networks Conference is designed to bring users and the telecommunications industry together. The Conference features sessions, panel discussions, and tutorials on voice, data, and electronic-mail communications. For information, contact Communication Networks, 375 Cochituate Rd, POB 880, Framingham MA 01701, (617) 879-0700.

January 15-16
Microcomputers in Education, Uses for the 80s, Arizona State University, Tempe AZ. The Tenth Annual Math/Science Conference will emphasize the microcomputer as a medium for instruction, as a tool for research, and as an information manager. Workshops, demonstrations, panel discussions, and problem-solving groups will be featured. Contact Nancy Watson, 203 Payne Hall, Arizona State University, Tempe AZ 85287.

January 19-22
Peripheral Array Processors for Signal Processing and Simulation, Sheraton National Hotel, Washington DC. The fee for this course is $795. For complete details, contact the Continuing Education Institute, 10889 Wilshire Blvd, Suite 1030, Los Angeles CA 90024, (213) 824-9545.

January 19-22
The Which Computer? Show, National Exhibition Centre, Birmingham, England. Information about this show can be obtained from Clapp & Poliak Inc, 245 Park Ave, New York NY 10167, (800) 223-1956; in New York (212) 661-8410.

January 20-22
Texas Computer Show, Dallas Convention Center, Dallas TX. Conferences, panel discussions, and seminars will be featured at this show. On display will be word- and data-processing equipment in addition to peripherals. For details, contact the Texas Computer Show, POB 214035, Dallas TX 75221, (214) 761-9108; in Georgia, (404) 452-0114; in Canada, (416) 252-7791.

January 28-30
Conference on Modeling and Simulation on Microcomputers, Bahia Hotel, San Diego CA. The Society for Computer Simulation (SCS) is presenting this conference. Papers, panel discussions, and tutorials on discrete and continuous simulation on microcomputers will be featured. Contact SCS, POB 2228, La Jolla CA 92038, (714) 459-3888.■

Linking a Pascal Microengine to a Cyber 170

Steven M Sedlet
931 Pebblebrook Dr
Lewisville TX 75067

Jonathan Dust
c/o BYTE Publications
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Hancock NH 03449

Microcomputers now on the market offer the speed, memory capacity, mass storage, and programming-language support facilities formerly available only on large mainframe computers. As a result, personal computers give users a convenient, inexpensive alternative to computing on larger machines. Personal computers, however, cannot offer the wide range of software utilities and applications packages or the variety of I/O (input/output) facilities available on large systems. The desire to incorporate the finer qualities of both modes of computing has motivated us to establish a mechanism for information and resource sharing between a personal computer, the Western Digital Pascal Microengine, and a large Control Data Corp Cyber 170 mainframe.

We have developed a file-transfer system to allow communication between the two machines. The Pascal Microengine, a hardware realization of UCSD's (University of California at San Diego) P-machine, is a desktop microcomputer for developing and executing Pascal programs. It is driven by a 16-bit processor that directly executes UCSD's p-code. The operating system consists of a Pascal compiler, a file manager, and a screen-oriented text editor. Mass storage for the Microengine system is provided by two Shugart single-density, single-sided 800R floppy-disk drives. Two RS-232 serial ports allow communication with the Microengine. One port is used for connection to the console (a serial video terminal). The second one, the remote port, is used to connect other RS-232 devices to the system. In our configuration, the remote port is connected to the Cyber by means of a modem.

The interface enables you to perform interactive processing on both the Microengine and the Cyber from the Microengine console. File transfers can be performed in both directions, allowing information and resource sharing between the two computers. The file-transfer system is written in UCSD Pascal and resides on the Pascal Microengine.

Why Have We Done This?

The value of interfacing two machines, such as the Pascal Microengine and the Cyber, extends beyond the ability to share data. You may take advantage of the finer points of each computer, consolidating their features to form an extended machine. For example, the interface between the Microengine and the Cyber allows you access to both the convenience of the screen-oriented editor on the Microengine and the power of the line-oriented editor, text formatter, and the fast central-processing unit with extended word lengths on the Cyber.

The ability to share data also allows for storage flexibility. A Pascal program written for the Microengine might be too large to practically store on a Microengine disk, but it can be stored on the Cyber. On the other hand, if you have space available on Microengine disks, it will be cheaper to store programs there rather than pay for disk space on the Cyber. Using the interface, the Microengine can also use the I/O features of the Cyber, taking advantage of line printers, card readers, and plotters, for example.

File-Transfer System

The file-transfer-system program is stored as object code and executed on the Microengine. When run, the program establishes communication with the IAF (Interactive Facility) on the Cyber. You may log onto IAF and perform interactive processing on the Cyber under NOS (Network Operating System). The file-transfer program is initially in Emulator Mode. In this mode, you may perform interactive processing under IAF or return to the Microengine interactive system by entering a Control-E at the console keyboard. Processing under IAF can be resumed, without logging in again, by reexecuting the file-transfer-system object code. All file trans-

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fers must be performed in the IAF NULL subsystem.

While in Emulator Mode, you may continue interactive processing on the Cyber, or may enter one of the Control-key commands. These include Control-E (exit), Control-R (receive), Control-T (transmit), Control-S (switch character-set modes), and Control-A (assistance). Receive Mode allows for the transfer of files from the Cyber to the Microengine. Transmit Mode enables the transfer of files from the Microengine to the Cyber. (The names of the two modes of transfer reflect the concept that file transfers are initiated from the Microengine, that is, files are either received at or transmitted from the Microengine.)

Control-S enables switching of character-set modes. There are two character sets recognized by the Cyber, Normal and ASCII (American Standard Code for Information Interchange). You must transfer a file in the proper mode to insure conversion between Cyber and Microengine character representations. In ASCII mode, the Cyber recognizes uppercase and lowercase ASCII characters. This mode of transfer is used only for text (nonexecutable) files. Normal mode must be used for transferring program files to the Cyber. In this mode, all alphabetic characters are interpreted as uppercase. Control-A may be entered to receive a menu of the above control key commands. Listing 1a demonstrates the use of the S and A control key commands.

Listing 1b demonstrates the interaction between the user and the file-transfer system when transferring files from the Cyber to the Microengine in Receive Mode. The file-transfer system performs the transfer by fetching the file to be transferred from your Cyber disk space, performing the transfer, and then cataloging it on Microengine disk using the UCSD Pascal filer system.

To access Receive Mode, you must enter a Control-R from the console, while in Emulator Mode. You will then receive confirmation at the console screen and be prompted for the name under which the file is to be cataloged on Microengine disk and the name of the Cyber file to be transferred. The file must reside on your permanent file space on the Cyber. Files that are strictly local will not be transferred. In response to either prompt, you may enter STOP, in which case control will return to Emulator Mode without performing the transfer. If legal file names are entered, you will be asked if the file is to be echoed at the console screen while the transfer is being made. Once you have responded to this prompt, the transfer is initiated. You may abort the transfer while in progress by entering an S (stop) at the console keyboard. If the transfer is aborted, you will receive the message:

TRANSFER TERMINATED BEFORE COMPLETION
—FILE NOT CATALOGED

and Emulator Mode will be resumed. Upon completion of a transfer, a message is written at the console and Emulator Mode is resumed.

Listing 1c demonstrates the command sequence during a transfer from the Microengine to the Cyber in Transmit Mode. To effect the transfer, the file is fetched from Microengine disk, transferred across the link to the Cyber, and cataloged in your Cyber disk space. The file will exist as the primary local file on the Cyber upon completion of the transfer.

Once Transmit Mode is entered, you will be prompted for the name of both the file to be transmitted and the name under which the file is to be cataloged on the Cyber. As in Receive Mode, you may enter STOP in response to either prompt in order to resume Emulator Mode without initiating the file transfer.

Once the file transfer has been initiated, it may be aborted by entering S at the console keyboard, in which case the message:

NO FILE TRANSFERRED

Text continued on page 476

Listing 1: *Sample runs of the various file-transfer-system commands. In listing 1a, the Control-A (assistance) and Control-S (switch character sets) commands are displayed. In listing 1b, the Control-R (receive file from Cyber) command is shown. Listing 1c gives an example of the Control-T (transmit file to Cyber) command.*

(1a)

```
(control-A)   (* user wishes to see menu of control key commands *)

CONTROL-E--->EXIT TO UCSD SYSTEM.
CONTROL-S--->SHIFT TRANSFER MODES (NORMAL<--->ASCII).
CONTROL-R--->RECEIVE FILES.
CONTROL-T--->TRANSMIT FILES
CONTROL-A--->ASSISTANCE : DISPLAY MENU.

THIS INTERFACE OPERATES ONLY IN CDC NULL SUBSYSTEM.

(control-S)   (* user wishes to switch character set modes *)

PROGRAM FILES MUST BE TRANSFERRED IN CDC NORMAL MODE.
TEXT FILES (U/L CASE) MUST BE TRANSFERRED IN CDC ASCII MODE.
PLEASE ENTER TRANSFER MODE N=NORMAL OR A=ASCII---> A
ASCII MODE
```

(1b)

```
(control-R)   (* user wishes to transfer file, CYBER-Microengine *)

FILE TRANSFER - CYBER TO MICROENGINE
NOTE : CDC FILE TO BE TRANSFERRED MUST BE PERMANENT

ENTER MICROENGINE FILENAME , E.G.  FILENAME.TEXT
                OR ENTER "STOP" TO TERMINATE
prime.text
ENTER NAME UNDER WHICH THE FILE IS CATALOGED ON THE CYBER
primnum
DO YOU WISH THE FILE TO BE ECHOED AS IT IS TRANSFERRED?  (Y/N) Y
             :
             :

             [listing of file]

             :
             :
EOT ENCOUNTERED
PRIMNUM CLOSED AND CATALOGED
```

(1c)

```
(control-T)   (* user wishes to transfer file, Microengine-CYBER *)

FILE TRANSFER - MICROENGINE TO CYBER

ENTER NAME OF FILE TO BE TRANSMITTED FROM THE MICROENGINE
                OR ENTER "STOP" TO TERMINATE
                E.G.  FILENAME.TEXT
prime.text
ENTER CDC FILENAME, OR ENTER "STOP" TO TERMINATE
NOTE : FILE WILL BECOME A CDC PERMANENT FILE,
             OLD PRIMARY FILE WILL BE LOST
primenum
DO YOU WISH THE FILE TO BE ECHOED AS IT IS TRANSFERRED ?  (Y/N) N

TRANSFER COMPLETE
PRIMNUM IS A CDC PERMANENT FILE
```

Text continued from page 474:

will appear at the console. If the transfer is allowed to run to completion, a message will be printed at the console. In either case, Transmit Mode will be terminated and Emulator Mode resumed.

File-Transfer Program

The file-transfer program that interfaces the Microengine to the Cyber (listing 2) is written in UCSD Pascal on the Microengine. It consists of three basic modules:

- the emulator
- the file transmit procedures (Microengine to Cyber)
- the file receive procedures (Cyber to Microengine)

The main program, which is the emulator, performs the communication between the Microengine console and the Cyber IAF system. It does this, alternately testing for input to the Microengine from the Cyber (remote port) and from the Microengine console (console port), by testing the status bits associated with each port. The status register for the console port is at address −1007 (two's complement) and the status register for the remote port is at address −991 (two's complement). Access to the status bit (bit 1 of the status registers) is achieved through a variant record:

```
type STATRG = record
  STATREG : packed array [0..7] of
            boolean
  end;
  STATREC = record
  case BVAR : boolean of
   TRUE : (STATREGADDR :
          integer ) ;
   FALSE : (STATPTR : STATRG)
  end;
```

The Boolean variable, BVAR, is originally set to true, and the variant field, STATREGADDR, is set to the address of the status register. This is done at the beginning of the file-transfer program. BVAR is then set false, making the variant field a

Text continued on page 486

Listing 2: *The emulator program, as written for the Pascal Microengine.*

```
PROGRAM EMULATOR ;

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  (* THIS PROGRAM PERFORMS THE FOLLOWING TASKS :                       *)
  (*    1. IT SERVES AS AN EMULATOR BETWEEN THE WESTERN DIGITAL        *)
  (*       PASCAL MICROENGINE AND THE CDC CYBER 171/172.  THE MAIN     *)
  (*       PROGRAM ALLOWS A USER AT THE MICROENGINE CONSOLE TO LOG     *)
  (*       INTO THE CYBER.                                             *)
  (*    2. IT PROVIDES FOR THE TRANSFER OF FILES FROM THE CYBER TO     *)
  (*       THE MICROENGINE, AND FROM THE MICROENGINE TO THE CYBER.     *)
  (*                                                                   *)
  (* IT IS INTENDED THAT THE PROGRAM WILL ULTIMATELY BE USED TO        *)
  (* EFFECT THE TRANSFER OF FILES BETWEEN COMPUTERS CONNECTED TO       *)
  (* RIAS RING NETWORK.  MODIFICATION WILL BE REQUIRED FOR THIS        *)
  (* PURPOSE.                                                          *)
  (*                                                                   *)
  (* THE PROGRAM MODULES CONSIST OF :                                  *)
  (*    MAIN PGM - THE EMULATOR, ALLOWS USER TO LOG INTO CYBER.        *)
  (*    RECEIVEFILE - ALLOWS THE TRANSFER OF A FILE FROM THE CYBER     *)
  (*                  TO THE MICROENGINE.                              *)
  (*    TRANSMITFILE - ALLOWS THE TRANSFER OF A FILE FROM THE          *)
  (*                   MICROENGINE TO THE CYBER.                       *)
  (*                                                                   *)

  (* PROGRAM EXECUTION :                                               *)
  (*    THE PROGRAM IS WRITTEN IN UCSD PASCAL AND RESIDES ON MICRO-    *)
  (*    ENGINE DISK.  TO INITIALLY EXECUTE THE PROGRAM, THE FILE,      *)
  (*    "EMULATOR.CODE" MUST BE FETCHED AND EXECUTED.  THE FILE        *)
  (*    "EMULATOR.TEXT" CONTAINS THE SOURCE CODE.  ONCE THE PRO-       *)
  (*    GRAM IS RUNNING, A CR WILL SOLICIT THE LOGIN MESSAGE FROM      *)
  (*    THE CYBER.                                                     *)
  (*                                                                   *)
  (*    ONCE LOGGED IN, THE USER MAY ISSUE ANY LEGAL TELEX COMMAND,    *)
  (*    AS WELL AS                                                     *)
  (*       CNTRL-E - EXITS EMULATOR AND RETURNS TO THE MICROENGINE     *)
  (*                 INTERACTIVE SYSTEM.  RE-EXECUTION OF THE PRO-     *)
  (*                 GRAM WILL RESUME TELEX, UNLESS THE USER HAS       *)
  (*                 BEEN TIMED-OUT IN THE MEANTIME.  WHEN             *)
  (*                 LOGGING OUT USING "BYE", HIT CNTRL-E AFTER        *)
  (*                 RECEIVING LOGOUT MESSAGE, THEN TURN OFF MODEM.    *)
  (*       CNTRL-R - PASSES CONTROL TO THE PROCEDURE "RECEIVEFILE",    *)
  (*                 ALLOWING THE TRANSFER OF A FILE FROM THE CYBER    *)
  (*                 TO THE MICROENGINE.                               *)
  (*       CNTRL-T - PASSES CONTROL TO PROCEDURE "TRANSMITFILE",       *)
  (*                 ALLOWING THE TRANSFER OF A FILE FROM THE          *)
  (*                 MICROENGINE TO THE CYBER.                         *)
  (*     IN THE LATTER 2 CASES THE PROGRAM WILL PROMPT THE USER FOR    *)
  (*     NECESSARY INFORMATION.  IN BOTH CASES THE FILE TRANSFER       *)
  (*     CAN BE TERMINATED WITH A CNTRL-S.                             *)
  (*                                                                   *)
  (* MAJOR DATA STRUCTURES :                                           *)
  (*    STATREC - RECORD USED TO ACCESS INDIVIDUAL BITS OF AN          *)
  (*              ADDRESS LOCATION, NECESSARY TO ALLOW EXAMINATION     *)
```

Listing 2 continued on page 478

Listing 2 continued:

```
(*                 OF THE SERIAL PORT STATUS REGISTERS FOR DETECTION*)
(*                 OF INPUT FROM THE CYBER OR FROM THE CONSOLE. THE *)
(*                 STRUCTURE IS ALSO USED TO CHANGE CERTAIN BITS OF *)
(*                 THE SERIAL STATUS REGISTERS (PP. 34-42, PASCAL   *)
(*                 MICROENGINE REFERENCE MANUAL).  INDIVIDUAL BIT   *)
(*                 ACCESS IS IMPLEMENTED BY USING A RECORD CONSIST- *)
(*                 OF A BOOLEAN FIELD AND A VARIANT FIELD. WHEN THE *)
(*                 BOOLEAN IS TRUE, THE VARIANT PART IS AN INTEGER  *)
(*                 & IS SET EQUAL TO THE ADDR OF A STATUS REGISTER. *)
(*                 WHEN THE BOOLEAN IS SET FALSE, THE VARIANT PART  *)
(*                 IS A POINTER INTO A PACKED ARRAY[0..7] OF        *)
(*                 BOOLEAN, ALLOWING ACCESS INTO THE 8 INDIVIDUAL   *)
(*                 BITS OF THE WORD.                                *)
(*                 THE RECORDS OF THIS TYPE ARE :                   *)
(*                    STATREG1 - USED TO DETECT IF A CHARACTER HAS  *)
(*                               BEEN ENTERED FROM THE CONSOLE.     *)
(*                    STATREG8 - USED TO DETECT IF A CHARACTER HAS  *)
(*                               BEEN SENT BY THE CYBER.            *)
(*                    PARITYON, PARITYODD - SEE PP. 37-42           *)
(*      T - A ONE ELEMENT ARRAY USED TO HOLD THE CHARACTER WRITTEN/*)
(*          READ TO/FROM THE SERIAL PORTS.  AN ARRAY IS USED,       *)
(*          RATHER THEN A CHAR VARIABLE, BECAUSE THE UCSD PASCAL    *)
(*          COMMANDS, UNITREAD AND UNITWRITE, REQUIRE AN ARRAY.     *)

TYPE STATRG =  RECORD
                 STATREG : PACKED ARRAY [0..7] OF BOOLEAN
               END ;
     STATREC = RECORD
                 CASE BVAR : BOOLEAN OF
                   TRUE  : (STATREGADDR  :INTEGER) ;
                   FALSE : (STATPTR : sTATRG)
                 END ;
VAR T : PACKED ARRAY [0..2] OF CHAR ;
    FOREVER : BOOLEAN ;
    STATREG1,STATREG8 : STATREC ;
    SKIP : BOOLEAN ;
    ASCII : BOOLEAN ;

PROCEDURE ASCIIMODE ;
  (* THIS PROCEDURE SETS THE CYBER CHARACTER MODE TO ASCII       *)
  VAR M : PACKED ARRAY [1..12] OF CHAR ;
  BEGIN  (* PROC ASCIIMODE *)
    M:='CSET,ASCII  ';
    M[11]:=CHR(13);
    UNITWRITE(8,M,11,0,1);
    UNITWAIT(8);
    UNITREAD(8,M,11,0,1);
    UNITWAIT(8);
    WRITELN('ASCII MODE') ;
    WRITELN
  END ;  (* PROC ASCIIMODE *)

PROCEDURE CHARMODE ;
  (* THIS PROCEDURE ALLOWS THE USER TO SWITCH CYBER CHARACTER    *)
  (* MODES  (NORMAL <--> ASCII)                                  *)
  VAR M : PACKED ARRAY [1..12] OF CHAR ;
  BEGIN  (* PROC CHARMODE *)
```

Listing 2 continued:

```
    WRITELN ;
    WRITELN('PROGRAM FILES MUST BE TRANSFERRED IN A CDC NORMAL MODE.') ;
    WRITELN('TEXT FILES (U/L CASE) MUST BE TRANSFERRED IN A CDC ASCII MODE.');
    WRITE('PLEASE ENTER TRANSFER MODE N=NORMAL OR A=ASCII--->') ;
    UNITREAD(1,M,1,0,1) ;
    UNITWAIT(1) ;
    WRITELN ;
    IF (M[1]='A') OR (M[1]='a')
      THEN BEGIN
             ASCII := TRUE ;
             ASCIIMODE
           END
      ELSE BEGIN
             ASCII := FALSE ;
             M := 'CSET,NORMAL ' ;
             M[12] := CHR(13) ;
             UNITWRITE(8,M,12,0,1) ;
             UNITWAIT(8) ;
             UNITREAD(8,M,11,0,1) ;
             UNITWAIT(8) ;
             WRITELN('NORMAL MODE') ;
             WRITELN
           END ;
    WRITELN
  END ;  (* PROC CHARMODE *)

PROCEDURE RECEIVEFILE ;
  (* TRANSFER A FILE FROM THE CYBER TO THE MICROENGINE.          *)
  (*    THE TRANSFER IS PERFORMED BY GENERATING A TELEX "TAPE"   *)
  (*    COMMAND FOLLOWED BY A "LIST" COMMAND.  TAPE              *)
  (*    MODE IS ENTERED TO ENABLE DETECTION OF AN EOT (END OF    *)
  (*    TEXT) CHARACTER.  THE CYBER FILE TRANSFERRED MUST BE THE *)
  (*    PRIMARY FILE.  THE FILE IS TRANSFERRED TO A BUFFER, THEN *)
  (*    ONTO THE MICROENGINE DISK.  A "NORMAL" COMMAND IS THEN   *)
  (*    GENERATED TO EXIT TAPE MODE.  *WARNING : THE NORMAL COM- *)
  (*    MAND WILL CAUSE CANCELLATION OF ASCII MODE.              *)

  VAR DONE : BOOLEAN ;
      O : STRING ;
      N : PACKED ARRAY [1..13] OF CHAR ;
      P : PACKED ARRAY [1..13] OF CHAR ;
      FILENAME : STRING ;
      RCVEFILE : TEXT ;
      USERTERM : BOOLEAN ;
      VERIFY : BOOLEAN ;
      BUFF1 : PACKED ARRAY [1..32766] OF CHAR ;
      BUFFINDEX : INTEGER ;
      I : INTEGER ;
      M : PACKED ARRAY [0..20] OF CHAR;
      BYE : BOOLEAN ;

  PROCEDURE RCVEREADY;
    BEGIN  (* PROC RCVEREADY *)
      P[1]:=CHR(10) ;
      P[2]:=CHR(13) ;
      P[3]:=CHR(10) ;
      P[4]:='R' ;
```

Listing 2 continued on page 480

Listing 2 continued:

```
    P[5]:='E' ;
    P[6]:='A' ;
    P[7]:='D' ;
    P[8]:='Y' ;
    P[9]:='.' ;
    P[10]:=' ' ;
    P[11]:=' ' ;
    P[12]:=CHR(13) ;
    P[13]:=CHR(10) ;
    IF P = N
      THEN BYE := FALSE
      ELSE BEGIN
             BYE := TRUE ;
             WRITELN('ERROR-CDC FILENAME NOT FOUND-CHK DIRECTORY')
           END
  END ;  (* PROC RCVEREADY *)

PROCEDURE LISTFILE ;
  BEGIN  (* PROC LISTFILE *)
    M[0] := 'T' ;
    M[1] := 'A' ;
    M[2] := 'P' ;
    M[3] := 'E' ;
    M[4] := CHR(13) ;
    UNITWRITE(8,M,5,0,1) ;
    UNITWAIT(8) ;
    UNITREAD(8,M,6,0,1) ;
    UNITWAIT(8) ;
    M[0] := 'L' ;
    M[1] := 'I' ;
    M[2] := 'S' ;
    M[3] := 'T' ;
    M[4] := CHR(13) ;
    UNITWRITE(8,M,5,0,1) ;
    UNITWAIT(8)
  END ;  (* PROC LISTFILE *)

BEGIN  (* PROC RECEIVEFILE *)
  CHARMODE;
  WRITELN('FILE TRANSFER - CYBER TO MICROENGINE') ;
  WRITELN('NOTE : CDC FILE TO BE TRANSFERRED MUST BE PERMANENT') ;
  WRITELN ;
  WRITELN('ENTER MICROENGINE FILENAME, E.G. FILENAME.TEXT') ;
  WRITELN('      OR ENTER "STOP" TO TERMINATE') ;
  READLN(FILENAME) ;
  IF FILENAME<>'STOP
    THEN BEGIN
           WRITELN('ENTER NAME UNDER WHICH THE FILE IS',
                   'CATALOGED ON THE CYBER') ;
           READLN(O) ;
           WRITE('DO YOU WISH THE FILE TO BE ECHOED AS IT IS',
                 ' TRANSFERRED ?  (Y/N) ') ;
           UNITREAD(1,T,1,0,1) ;
           UNITWAIT(1);
           WRITELN ;
           IF T[0] = 'Y'
```

Listing 2 continued:

```
            THEN VERIFY := TRUE
            ELSE VERIFY := FALSE ;
          M[0]:='O' ;
          M[1]:='L' ;
          M[2]:='D' ;
          M[3]:=',' ;
          FOR I :=1 TO LENGTH(O) DO
          M[I+3] := O[I] ;
          M[LENGTH(O)+4]:=CHR(13) ;

I:=(LENGTH(O)+5) ;
UNITWRITE(1,M,I,0,1) ;
UNITWRITE(8,M,I,0,1) ;
UNITREAD(8,M,13,0,1) ;
UNITWAIT(8) ;
FOR I:=0 TO 12 DO N[I+1] := M[I]
RCVEREADY ;
IF BYE=TRUE
  THEN EXIT(RECEIVEFILE)
  ELSE LISTFILE ;
USERTERM := FALSE ;
DONE := FALSE ;
BUFFINDEX := 0 ;
WHILE (NOT DONE) AND (NOT USERTERM) DO
  BEGIN
    BUFFINDEX := BUFFINDEX + 1 ;
    UNITREAD(8,T,1,0,1) ;
    UNITWAIT(8);
    IF ORD(T[0]) = 17 THEN DONE := TRUE ;
    IF ORD(T[0]) = 13
      THEN BEGIN
             IF VERIFY THEN WRITELN
           END
      ELSE IF ORD(T[0]) <> 10 THEN IF VERIFY THEN WRITE(T[0]) ;
    BUFF1[BUFFINDEX] := T[0] ;
    IF STATREG1.STATPTRSTATREG[1] = TRUE
      THEN BEGIN
             UNITREAD(1,T,1,0,1) ;
             UNITWAIT(1) ;
             IF ORD(T[0]) = 19 THEN USERTERM := TRUE
           END
  END ;
IF NOT USERTERM
  THEN BEGIN
         M:='NORMAL                ' ;
         M[6]:=CHR(13) ;
         UNITWRITE(8,M,7,0,1) ;
         UNITWAIT(8) ;
         UNITREAD(8,M,9,0,1) ;
         UNITWAIT(8) ;
         IF ASCII=TRUE THEN ASCIIMODE ;
         WRITELN('EOT ENCOUNTERED') ;
         REWRITE(RCVEFILE,FILENAME) ;
         FOR I := 1 TO BUFFINDEX DO
           IF ORD(BUFF1[I])=13
             THEN WRITELN(RCVEFILE)
```

Listing 2 continued on page 482

Listing 2 continued:

```
                    ELSE IF ORD(BUFF1[I]) <> 10
                            THEN WRITE(RCVEFILE,BUFF1[I]) ;
                 CLOSE(RCVEFILE,LOCK) ;
                 WRITELN ;
                 WRITELN(FILENAME,' CLOSED AND CATALOGED')
               END
               ELSE BEGIN
                     T[0] := 'S' ;
                     UNITWRITE(8,T,1,0,1) ;
                     UNITWAIT(8) ;
                     UNITREAD(8,T,15,0,1) ;
                     UNITWAIT(8) ;
                     WRITELN ;
                     WRITELN ;
                     WRITELN('TRANSFER TERMINATED BEFORE COMPLETION',
                             ' - FILE NOT CATALOGED')
                   END ;
          END
      ELSE WRITELN('NO FILE TRANSFERRED')
  END ;  (* PROC RECEIVEFILE *)


PROCEDURE TRANSMITFILE ;
  (* TRANSFER A FILE FROM THE MICROENGINE TO THE CYBER.            *)
  (*    TRANSFER IS PERFORMED BY CREATING A PRIMARY CYBER FILE,    *)
  (*    ENTERING TEXT MODE, AND TRANSMITTING THE MICROENGINE FILE*)
  (*    TO THE CYBER.  AFTER THE FILE IS TRANSFERRED, A "BREAK"    *)
  (*    (CNTRL-C) IS GENERATED, FOLLOWED BY A "PACK" COMMAND.      *)
  (*    THE TRANSFERRED M.E. FILE IS THEN THE CDC PRIMARY FILE,    *)
  (*    AND MUST BE SAVED IF THE USER WISHES TO RETAIN IT.         *)
  (*    IF THE TRANSFER IS TERMINATED BY A CNTRL-S, THE REST OF    *)
  (*    THE FILE IS READ AND BLANK LINES TRANSMITTED TO THE        *)
  (*    CYBER.  THIS IS NECESSARY DUE TO THE TIMING CONSTRAINTS    *)
  (*    BETWEEN THE TWO COMPUTERS.                                 *)

  VAR DONE : BOOLEAN ;
      Z    : INTEGER ;
      X    : STRING ;
      FILENAME : STRING ;
      TRANSFILE : TEXT ;
      CDCFILENAME : STRING ;
      USERTERM : BOOLEAN ;
      VERIFY : BOOLEAN ;
      CH : CHAR ;
      I : INTEGER ;
      M : PACKED ARRAY [0..20] OF CHAR ;

  PROCEDURE XMITRDFILE ;
  (* THIS PROCEDURE TRANSMITS A CHARACTER FROM THE MICROENGINE     *)
  (* TO THE CYBER.                                                 *)

    BEGIN  (* PROC XMITRDFILE *)
      READ(TRANSFILE,CH) ;
      T[0] := CH ;
      IF NOT USERTERM
         THEN BEGIN
```

Listing 2 continued:

```
               UNITWRITE(8,T,1,0,1) ;
               UNITWAIT(8) ;


               IF VERIFY THEN WRITE(T[0])
             END  ;
     IF EOLN(TRANSFILE)
        THEN BEGIN
               IF (NOT USERTERM) AND (VERIFY)
                  THEN WRITELN ;
               T[0] := CHR(13) ;
               T[1] := CHR(10) ;
               UNITWRITE (8,T,2,0,1) ;
               UNITWAIT(8) ;
               READLN(TRANSFILE)
             END  ;
     IF STATREG1.STATPTRSTATREG[1] = TRUE
        THEN BEGIN
               UNITREAD(1,T,1,0,1) ;
               UNITWAIT(1) ;
               IF ORD(T[0]) = 19 THEN USERTERM := TRUE
             END
  END ;  (* PROC XMITRDFILE *)

PROCEDURE REPLACEFILE ;
  BEGIN  (* PROC REPLACEFILE *)
    X:='REP';
    FOR I := 0 TO (LENGTH(X)-1) DO
    M[I] := X[I+1] ;
    M[3] := CHR(13) ;
    UNITWRITE(8,M,4,0,1) ;
    UNITWAIT(8) ;
    UNITREAD(8,M,13,0,1) ;
    UNITWAIT(8)
  END ;  (* PROC REPLACEFILE *)


BEGIN  (* PROC TRANSMITFILE *)
  CHARMODE ;
  WRITELN('                 FILE TRANSFER - MICROENGINE TO CYBER') ;
  WRITELN('ENTER NAME OF FILE TO BE TRANSMITTED FROM MICROENGINE') ;
  WRITELN('OR ENTER "STOP" TO TERMINATE') ;
  WRITELN('E.G. FILENAME.TEXT') ;
  READLN(FILENAME) ;
  IF FILENAME <> 'STOP                '
    THEN BEGIN
           RESET(TRANSFILE,FILENAME) ;
           WRITELN(FILENAME, ' OPENED') ;
           WRITELN ;
           WRITELN('ENTER CDC FILENAME, OR ENTER "STOP" TO TERMINATE') ;
           WRITELN('NOTE : FILE WILL BECOME A CDC PERMANENT FILE, ',
                   'OLD PRIMARY FILE WILL BE LOST') ;
           READLN(CDCFILENAME) ;
           IF CDCFILENAME <> 'STOP   '
             THEN BEGIN
                    WRITELN ;
```

Listing 2 continued on page 484

Listing 2 continued:

```
WRITE('DO YOU WISH THE FILE TO BE ECHOED',
      AS'IT IS TRANSFERRED ? (Y/N) ') ;
UNITREAD(1,T,1,0,1) ;
WRITELN ;
IF T[0] = 'Y'
  THEN VERIFY := TRUE
  ELSE VERIFY := FALSE ;
M[0] := 'N' ;
M[1] := 'E' ;
M[2] := 'W' ;
M[3] := ',' ;
FOR I := 1 TO LENGTH(CDCFILENAME) DO
  M[I+3] := CDCFILENAME[I] ;
M[LENGTH(CDCFILENAME) + 4] := CHR(13) ;
Z := (LENGTH(CDCFILENAME))+5 ;
UNITWRITE(8,M,Z,0,1) ;
UNITWAIT(8) ;
UNITREAD(8,M,13,0,1) ;
UNITWAIT(8) ;
M[0] := 'T' ;
M[1] := 'E' ;
M[2] := 'R' ;
M[3] := ',' ;
M[4] := 'B' ;
M[5] := 'L' ;
M[6] := 'K' ;
M[7] := 'E' ;
M[8] := 'D' ;
M[9] := 'T' ;
M[10] := CHR(13) ;
UNITWRITE(8,M,11,0,1) ;
UNITWAIT(8) ;
UNITREAD(8,M,11,0,1) ;
UNITWAIT(8) ;
M[0] := 'T' ;
M[1] := 'E' ;
M[2] := 'X' ;
M[3] := CHR(13) ;
M[4] := CHR(10) ;
UNITWRITE(8,M,5,0,1) ;
UNITWAIT(8) ;
UNITREAD(8,M,18,0,1) ;
UNITWAIT(8) ;
DONE := FALSE ;
USERTERM := FALSE ;
WRITELN ;
WHILE NOT EOF(TRANSFILE) DO XMITRDFILE;
M[0] := CHR(13) ;
M[1] := CHR(10) ;
M[2]:=CHR(3) ;
UNITWRITE(8,M,3,0,1) ;
UNITWAIT(8) ;
UNITREAD(8,M,18,0,1) ;
UNITWAIT(8) ;
M[0] := 'T' ;
M[1] := 'E' ;
```

Listing 2 continued:

```
                        M[2] := 'R' ;
                        M[3] := ',' ;
                        M[4] := 'T' ;
                        M[5] := 'T' ;
                        M[6] := 'Y' ;
                        M[7] := CHR(13) ;
                        M[8] := CHR(10) ;
                        UNITWRITE(8,M,9,0,1) ;
                        UNITWAIT(8) ;
                        UNITREAD(8,M,10,0,1) ;
                        UNITWAIT(8) ;
                        M[0] := 'P' ;
                        M[1] := 'A' ;
                        M[2] := 'C' ;
                        M[3] := CHR(13) ;
                        UNITWRITE(8,M,4,0,1) ;
                        UNITWAIT(8) ;
                        UNITREAD(8,M,13,0,1) ;
                        UNITWAIT(8) ;
                        REPLACEFILE ;
                        IF NOT USERTERM
                          THEN WRITELN('TRANSFER COMPLETE')
                          ELSE WRITELN('TRANSFER TERMINATED BEFORE COMPLETION') ;
                        WRITELN(CDCFILENAME, ' IS A CDC PERMANENT FILE')
                      END
                 ELSE WRITELN('NO FILE TRANSFERRED')
             END
        ELSE WRITELN('NO FILE TRANSFERRED')
    END ;  (* PROC TRANSMITFILE *)

  PROCEDURE PRNTHELP ;
    (* THIS PROCEDURE PRINTS OUT THE MENU OF CONTROL KEY COMMANDS. *)

    BEGIN  (* PROC PRNTHELP *)
      WRITELN ;
      WRITELN ;
      WRITELN(' CONTROL-E--->EXIT TO UCSD SYSTEM.') ;
      WRITELN(' CONTROL-S--->SHIFT TRANSFER MODES (NORMAL<-->ASCII).') ;
      WRITELN(' CONTROL-R--->RECEIVE FILES.') ;
      WRITELN(' CONTROL-T--->TRANSMIT FILES.') ;
      WRITELN(' CONTROL-H--->DISPLAY ABOVE CONTROL COMMANDS.') ;
      WRITELN
    END ;  (* PROC PRNTHELP *)

    BEGIN  (* MAIN PROGRAM - TERMINAL EMULATOR *)
      PRNTHELP ;
      WRITELN(' PLEASE TYPE RETURN FOR LOGIN MESSAGE IF NOT LOGGED IN.');
      STATREG1.BVAR := TRUE ;
      STATREG8.BVAR := TRUE ;
      STATREG1.STATREGADDR := -1007 ;
      STATREG8.STATREGADDR := -991 ;
      STATREG1.BVAR := FALSE ;
      STATREG8.BVAR := FALSE ;
      UNITCLEAR(8) ;
      UNITCLEAR(1) ;
      FOREVER := TRUE ;
      WHILE FOREVER DO
```

Listing 2 continued on page 486

Text continued from page 476:

pointer into a Boolean packed array. Since the memory address associated with this field has been previously set to the address of the status register, and because a pointer type is merely an address of a memory location, we now have a pointer into the individual bits of the status register.

In Emulator Mode, the status bits associated with the two ports are alternately tested. If input is detected at the remote port, a *unitread* instruction is executed to fetch the character, followed by a *unitwrite* command to the console. These instructions are UCSD Pascal low-level intrinsics for accessing a peripheral device. Linefeeds (ASCII character 10) are not echoed. At the end of a line, the Cyber transmits a carriage return followed by a linefeed. On the Microengine a carriage return implies a linefeed, so the linefeed from the Cyber is redundant. If input is detected at the console port, a "unitread" is initiated to fetch the character. The character is first checked to determine if it is one of the previously discussed control-key commands, in which case the appropriate action is taken. If the character is not a control character, the emulator assumes it is meant for the Cyber, and it is transferred to the remote port by execution of a "unitwrite" command.

Input to the remote port is given priority over input to the console port so that the stream from the Cyber is not interrupted. This is implemented by placing the code for testing the remote-port status bit in a "while" loop and the code for testing the console-port status bit in an "if" statement in the main program. As long as characters are being received at the remote port, the emulator will continue to read them and echo them to the console. Only when there are no more characters detected at the remote port is the console-port status bit checked. Even then, only one character is accepted before the remote-port status bit is again tested. Consequently, characters entered at the console while information is being sent by the Cyber are displayed, but ignored.

Listing 2 continued:

```
                BEGIN
                  WHILE STATREG8.STATPTRSTATREG[1]=TRUE DO
                    BEGIN
                      UNITREAD(8,T,1,0,1) ;
                      UNITWAIT(8) ;
                      IF ORD(T[0]) <> 10
                        THEN BEGIN
                               UNITWRITE(1,T,1,0,1) ;
                               UNITWAIT(1)
                             END
                    END ;
                  IF STATREG1.STATPTRSTATREG[1]=TRUE
                    THEN BEGIN
                           UNITREAD(1,T,1,0,1) ;
                           UNITWAIT(1) ;
                           SKIP := FALSE ;
                             IF ORD(T[0])=05
                               THEN BEGIN
                                      FOREVER := FALSE ;
                                      SKIP := TRUE
                                    END ;
                             IF ORD(T[0])=18
                               THEN BEGIN
                                      RECEIVEFILE ;
                                      SKIP := TRUE
                                    END ;
                             IF ORD(T[0])=20
                               THEN BEGIN
                                      TRANSMITFILE ;
                                      SKIP := TRUE
                                    END ;
                             IF ORD(T[0])=19
                               THEN BEGIN
                                      CHARMODE ;
                                      SKIP := TRUE
                                    END ;
                             IF ORD(T[0])=08 THEN PRNTHELP ;
                             IF SKIP=FALSE
                               THEN BEGIN
                               UNITWRITE(8,T,1,0,1) ;
                               UNITWAIT(8)
                             END
                  END
          END
    END.
```

File transfer from the Cyber to the Microengine is performed by the procedure RECEIVEFILE. The transfer is implemented by generating an

OLD, filename

IAF command to fetch the file from your Cyber file space. The procedure then waits for a READY response from the Cyber. If it does not receive the response, the routine assumes that the file was not found, that is, the Cyber actually generated a

filename NOT FOUND

response.

In the latter case, an error message is printed at the console and Emulator Mode is resumed. You must then re-enter Receive Mode to reattempt the file transfer. It is because of this type of response by the Cyber that file transfers must be performed in the IAF NULL subsystem. The response made by IAF to commands differs between IAF subsystems, and the file-transfer program was designed to accommodate the responses made in the NULL subsystem.

If the file is successfully fetched, the routine generates a TAPE command, causing the Cyber to enter the TAPE subsystem under IAF. Performing the transfer in this subsystem is necessary since it is only in this mode that the Cyber generates an EOT (end-of-text) character to allow detection of transfer completion. The actual transfer is initiated by generating an IAF LIST command.

The transfer is performed by reading the listed output from the Cyber, at the remote port, into a buffer in Microengine memory, BUFF1, consisting of an array of characters. Upon completion of the transfer, BUFF1 is written to Microengine disk. It is necessary to use this intermediate storage because of the activity of the Microengine disk-drive head as a file is written. At certain intervals as it is writing, the head must position itself to available partitions. In doing so, it misses a few characters, since the Cyber will not withhold its transmission to allow positioning of the disk head. This, of course, is allowed for when writing from Microengine memory to disk, and so the writing of the file to Microengine disk is postponed until the file transfer is completed. (Because of this use of intermediate storage, the size of Microengine memory places a limit of 32,767 characters on the size of files received from the Cyber.)

During the transfer, certain characters must be noted. If you have requested echoing of the file to the console as it is transferred, a "writeln" command must be generated if a carriage return (ASCII character 13) is detected from the Cyber. As in Emulator Mode, a linefeed is redundant and must not be echoed to the screen.

The detection of an EOT (ASCII character 17) indicates the completion of the transfer. If the transfer is terminated by detection of an EOT character, a suitable message is written to the console, BUFF1 is written to Microengine disk, the file is cataloged and closed, and Emulator Mode is resumed.

If, during file transfer, an S is entered at the console keyboard, it is transmitted to the Cyber, causing the listing of the file to be terminated. A termination message is written to the console screen and Emulation Mode is resumed without writing BUFF1 to Microengine disk.

Since IAF was placed in the TAPE subsystem in order to enable the detection of an EOT mark, it must now be returned to the NULL subsystem. This is done, before returning to Emulator Mode, by generating a Normal command to IAF. If, however, you have been operating in ASCII Mode, you will want to remain in that mode. To this purpose, a Boolean variable, ASCII, is maintained to keep track of the character mode. If ASCII is true, the character-set mode is switched to ASCII before returning to Emulator Mode.

Transmission of a file from the Microengine to the Cyber is performed by the procedure TRANSMITFILE. After you are prompted for the name of the Microengine file to be transferred, the file is opened and you will be prompted for the name under which the file is to be cataloged on the Cyber. Keying in STOP in place of either file name will terminate Transmit Mode and resume Emulator Mode without initiating the transfer. The transfer is performed by generating a

NEW, Cyber filename

IAF command, thus creating a new primary local file on the Cyber and listing the Microengine file to the Cyber. Since a new primary file is created, the user must take care to save the old primary file before entering Transmit Mode.

Before the transfer is initiated, BLKEDIT mode is entered in IAF by generating a

TERM,BLKEDIT

command. BLKEDIT mode is designed to allow multiple-line input from a terminal to the Cyber, rather than line-by-line transmission. In this mode, the file transmission can be viewed as a stream of characters instead of a series of lines. Thus, the Microengine does not have to wait for the Cyber to accept each line before transmitting the next.

Following the command, a

TEXT

IAF command is generated to allow the file transmitted from the Microengine to be read into the newly defined CYBER file. Then, the nested procedure XMITRDFILE performs the transfer. When the transfer is completed, BLKEDIT mode is terminated and Cyber filename is cataloged on the Cyber by generation of TERM, TTY, and REPLACE IAF commands.

In addition to the two transfer routines (with nested procedures) and the emulator (main) routine, there are two other procedures:

1. CHARMODE allows the user to choose the character-set mode (Normal or ASCII) for file transfer. It is accessed by entering a Control-S while in Emulator Mode.

2. PRNTHELP lists the menu of control commands available to the user in Emulator Mode. PRNTHELP is accessed by entering Control-A while in Emulator Mode.

Limitations, Tradeoffs, Extensions

Our file-transfer system has been used extensively at data rates up to 1200 bps (bits per second) and has proven successful in its intended purpose. The system does contain some limitations, however, either due to tradeoffs between versatility and simplicity or as a result of the inherent qualities of the machines. One such limitation is the constraint that all file transfers must be performed under the Cyber NULL subsystem. As described earlier, this is necessary since the program must test for certain responses from the Cyber. Originally, a "busy wait," in the form of an empty Pascal "for" loop, was used to halt program execution until the Cyber had generated its response. In this way, the Microengine did not have to wait for a specific response, but only had to make sure that it gave the Cyber sufficient time to generate it. Because of the variation in response time by the Cyber, coupled with the rapid processing of the Microengine, the range of the loop bounds had to be made very large to insure that the Cyber had completed its response before the Microengine resumed execution of the file-transfer program. So instead of employing the "busy wait," the program was tailored to the responses made by the Cyber in the NULL subsystem. This approach was cleaner and more efficient but was chosen at the cost of

Circle 81 on inquiry card.

versatility. The program can be extended to accept responses made under other subsystems as well, but this would lengthen the program size considerably.

Another such limitation is the restriction on the size of files transferred from the Cyber to Microengine disk, due to the use of a memory buffer. A large file can be transferred by dividing it into smaller files on the Cyber, transmitting the files separately and merging them at the Microengine. If more memory is available, the buffer size can be increased to allow the transfer of large files.

The file-transfer system might also be extended to allow the transfer of object-code files. Due to the incompatibility of binary codes on the two machines, a remapping of the codes would be required for file transfers in both directions. Again, this enhancement would considerably increase the size of the transfer program.

When we designed the file-transfer system, we intended it to be adapted, with minimal modification, to other microcomputers and minicomputers. The program was also designed for eventual use as a skeleton of a file-transfer system for a network of computers in the Department of Computer Science at Colorado State University.

At present, the system has been adapted to an Altair 8800 and an Intertec SuperBrain. The primary modification made to the program, in order to adapt it to the Altair, was in the emulator section. In the Microengine, the serial-port status registers are memory-mapped and can be tested using the Pascal record construct presented earlier. The ports on the Altair cannot be tested in this manner. The UCSD Pascal system allows assembly-language linking to Pascal programs, however, and so the adaptation to the Altair was made possible by the addition of two assembly-language functions, one to test the port to the Cyber and one to test the port connected to the system console. (The listing of modifications to the file-transfer-system program can be obtained from the authors.) ■

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Ada, An Introduction, Ada Reference Manual, Henry Ledgard. New York: Springer-Verlag, 1981; 26.5 by 18.75 cm, 373 pages, softcover, ISBN 0387-90568-5, $12.95.

Apple BASIC for Business, For the Apple II, Alan J Parker and John F Stewart. Reston VA: Reston Publishing, 1981; 17.5 by 23.5 cm, 301 pages, softcover, ISBN 0-8359-0226-1, $14.95; hardcover, ISBN 0-8359-0228-5, $17.95.

Beyond COBOL, Gary D Brown. New York: John Wiley & Sons, 1981; 15.5 by 23.5 cm, 200 pages, hardcover, ISBN 0-471-09030-1, $17.50.

Computer Peripherals, Barry Wilkinson and David Horrocks. New York: Crane Russak & Company, 1981; 15.5 by 23.5 cm, 310 pages, softcover, ISBN 0-340-32652-3, $19.75.

Data Processing with Applications, 2nd ed, Robert J Condon. Reston VA: Reston Publishing Company, 1981; 15.5 by 23.5 cm, 477 pages, hardcover, ISBN 0-8359-1254-X, $16.95.

Digital Circuits and Systems, Richard L Castellucis. Reston VA: Reston Publishing Company, 1981; 16 by 23.5 cm, 332 pages, hardcover, ISBN 0-8359-1297-3, $18.95.

Executive Computing, How to Get It Done on Your Own, John M Nevison. Reading MA: Addison-Wesley, 1981; 16 by 23.5 cm, 319 pages, softcover, ISBN 0-201-05248-2, $8.95.

50 Programs in Basic for the Home, School & Office, Jim Cole. Woodsboro MD: ARCsoft Publishers, 1981; 14 by 21.5 cm, 80 pages, softcover, ISBN 0-86668-002-0, $9.95.

Finite Elements, An Introduction, Volume I, Eric

Becker, Graham F Carey, and J Tinsley Oden. Englewood Cliffs NJ: Prentice-Hall, 1981; 15.5 by 23.5 cm, 258 pages, hardcover, ISBN 0-13-317057-8, $24.95.

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The Hexadecimal Chronicles, Don Lancaster. Indianapolis IN: Howard W Sams & Company, 1981; 21.5 by 28 cm, 377 pages, softcover, ISBN 0-672-21802-X, $17.95.

How to Get Started with CP/M, Carl Townsend. Beaverton OR: dilithium Press, 1981; 14 by 22 cm, 127 pages, softcover, ISBN 0-918398-32-0, $9.95.

Introduction to Computers and Information Processing, Language Edition, Don Cassel and Martin Jackson. Reston VA: Reston Publishing Company, 1981; 18 by 24 cm, 472 pages, hardcover, ISBN 0-8359-3150-1, $19.95.

An Introduction to Computer Programming and Data Structures Using MACRO-11, Harry R Lewis. Reston VA: Reston Publishing Company, 1981; 18.5 by 24 cm, 241 pages, hardcover, ISBN 0-8359-3143-9, $18.95.

Jewels of Formal Language Theory, Arto Salomaa. Rockville MD: Computer Science Press, 1981; 16 by 23.5 cm, 144 pages, hardcover, ISBN 0-914894-69-2, $24.95.

Knowledge and the Flow of Information, Fred I Dretske. Cambridge MA: The MIT Press, 1981; 16 by 24 cm, 273 pages, hardcover, ISBN 0-262-04063-8, $18.50.

Microcomputer Power Series, Data Management Techniques, John P Grillo and J D Robertson. Dubuque IA: Wm C Brown Company Publishers, 1981; 21.5 by 28 cm, 208 pages, softcover,

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ISBN 0-697-09954-7, $16.95.

Microcomputer Power Series, Guide to System Applications. Same as above; 288 pages, softcover, ISBN 0-697-09952-0, $17.95.

Microcomputer Power Series, Introduction to Graphics. Same as above; 144 pages, softcover, ISBN 0-697-09953-9, $15.95.

Microcomputer Power Series, Techniques of BASIC. Same as above; 272 pages, softcover, ISBN 0-697-09951-2, $18.95.

Microsystems '81, Proceedings of the 4th Annual Conference (London, March 11-13, 1981). Westbury House, division of IPC Science and Technology Press (POB 63, Bury Street, Guilford, Surrey, England, GU2 5BH), 1981; 16.5 by 23.5 cm, 124 pages, softcover, ISBN 0-86103-046-X, £12.50.

Osborne 16-Bit Microprocessor Handbook, Adam Osborne, Gerry Kane. Berkeley CA: Osborne/McGraw-Hill, 1981; 18 by 23 cm, 771 pages, softcover, ISBN 0-931988-42-X, $19.95.

Pascal Programs for Scientists and Engineers, Alan R Miller. Berkeley CA: Sybex, 1981; 18 by 23 cm, 374 pages, softcover, ISBN 0-89588-058-X, $16.95.

Representations, Philosophical Essays on the Foundations of Cognitive Science, Jerry A Foder. Cambridge MA: The MIT Press, 1981; 16 by 24 cm, 343 pages, hardcover, ISBN 0-262-06079-5, $20.

67 Ready-To-Run Programs in BASIC: Graphics, Home & Business, Education, Games, William Scott Watson. Blue Ridge Summit PA: Tab Books, 1981; 13.5 by 21 cm, 182 pages, softcover, ISBN 0-8306-1195-9, $6.95; hardcover, ISBN 0-8306-9660-1, $12.95.

Sociological Methods & Research, Volume 9, Number 4, edited by David R Heise. Beverly Hills CA: Sage Publications, 1981; 13.5 by 21.5 cm, 141 pages, softcover, ISSN 0049-1241, $5.50.

Structured Requirements Definition, Ken Orr. Topeka KS: Ken Orr and Associates, 1981; 15 by 23 cm, 235 pages, softcover, ISBN 0-9605884-0-X, $25.

Taming Your Computer, A Guide for Business and Professional People, Jerome Kanter. Englewood Cliffs NJ: Prentice-Hall, 1981; 18.5 by 24 cm, 246 pages, hardcover, ISBN 0-13-884403-8, $17.95; softcover, ISBN 0-13-884395-3, $8.95.

Telecommunications Management for Business and Government, 2nd ed. Larry A Arredondo, edited by Harry Newton. New York: Telecom Library, 1981; 21.5 by 28 cm, 270 pages, softcover, ISBN 0-936648-07-4, $30.

32 BASIC Porgrams for the Apple Computer, Tom Rugg and Phil Feldman. Beaverton OR: dilithium Press, 1981; 13.5 by 21 cm, 284 pages, softcover, ISBN 0-918398-34-7, $17.95.

The Year of the Robot, Wayne Chen. Beaverton OR: dilithium Press, 1981; 13.5 by 21 cm, 182 pages, softcover, ISBN 0-918398-50-9, $7.95. ■

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.

Information Hiding in Pascal

Packages and Pointers

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Information hiding is the principle that allows programs written at a *high level* to be insulated from messy *low-level* details. This principle fosters program reliability for two related reasons:

- Since low-level details are relegated to lower-level programs (procedures, functions, macroinstructions, etc), they can, in principle, be coded *once*, instead of once per program. Thus, the detailed code need be debugged only once. Moreover, the calling programs cannot disturb them because they cannot gain access to these details.
- High-level programs, being insulated from low-level details, can be written more cleanly, making them easier to maintain. Since higher-level programmers know that lower-level details have already been debugged, they can concentrate on their assigned task—writing the higher-level material.

Information hiding is equally valid for single- and multi-programmer tasks. It is clear that even a single programmer can benefit from writing low-level code only once.

What Is a Package?

One important application of the information-hiding principle is in the definition, in some programming language, of new data types not already supported. Pascal, for example, does not support complex numbers—at least in the standard language. A *package*, also called a *class* or *data abstraction*, is an encapsulation of a new data type, together with a set of primitive functions or procedures that handles the details of creating instances of the new type and performing operations on it.

To continue with our example of complex numbers, a complex-number package generally contains the following parts:

- a definition of complex data as consisting of a real part and an imaginary part
- a method to be used by higher-level programs in creating new complex data, given two integers or real numbers to serve as the real and imaginary components
- a set of operations on complex numbers so higher-level programs can do arithmetic on complex numbers without needing access to the details of what complex numbers look like internally

Such a set of operations should ordinarily be *minimal* (without redundant operations) and *complete* (ie: calling routines don't need any additional operations to do everything required). For complex numbers, we would need sum, difference, product, quotient, and absolute value or magnitude operations, plus some comparison operations, such as equals, less than, greater than, etc. The general idea is that this extended data type "comes with" the same general level of support offered by the base language for integers and real numbers.

Ideally, a package should be defined by two pieces: a *functional specification* of the type and its operations, which gives a list of the legal operations and a description of *what* each operation does (not *how*), and a *group of programs* implementing the operations and responsible for handling the messy lower-level details.

Jean Ichbiah, developer of the new Ada language, explains the package idea by referring to a wristwatch—say, one of the new digital ones with many features. The owner's guide describes the watch's features, explaining what each button does (time, date, light, set alarm, and so on). The user receives a warranty from the manufacturer that the watch will perform as advertised. It is not necessary to know anything about how the watch works to use it effectively. Furthermore, the manufacturer would probably refuse to honor the warranty on a watch whose internal circuits have been tampered with. So, the internal parts of a watch are—we hope—packaged to discourage tampering. Indeed, more complex equipment is often packaged with a lock or seal. This way, only an authorized technician can get inside, or an attempt by a user to get in will be obvious and void the warranty.

Ichbiah asserts that software producers are going to be called upon more and more to guarantee their products. However, it will be difficult to give an effective warranty on products whose reliability has not been proven (at least to our own satisfaction; recalls occur in many industries). More important, it is difficult to guarantee a product whose internal parts can be tampered with by a user. Packages, then, are a way to foster warrantableness.

There are several programming languages that support variations on the package theme. The language SIMULA67, used more in Europe than in the United States, provides a similar concept called *class*; experimental languages such as Concurrent Pascal, CLU, and Alphard support the idea in one form or another, and Ada emphasizes packages by that name as an important principle of modular design. Standard Pascal does not support packages as such; let us examine how we can implement their principle in Pascal.

Packages in Standard Pascal

A package should consist of a functional specification—ideally recognized by the compiler—and an implementation module. Pascal has no facility for separating the specification part from the implementation part. Therefore, we write the specification part, in an appropriate style, as a block comment.

Also implicit in the notion of a package is the fact that we can physically isolate the package from other packages and calling programs. Unfortunately, Pascal is not much help here, since neither a compile-time facility for copying separate pieces of source text into a source file nor a facility for separate compilation of packages is supported. Many implementations of Pascal provide one or both of these, but this discussion is limited to the possibilities of the standard language.

Another limitation of Pascal is that all type definitions must appear in one group following a "type" keyword, and these must appear before all code for functions and procedures. This hinders the ability to group a type definition with all its operations, another type to be grouped with its operations, and so on. Once again, there are some implementation-dependent relaxations of this rule.

A Pascal Complex-Number Package

To summarize the previous sections, Pascal does not permit the *direct* production of packages because of its lack of separate compilation facilities and its rigid syntax for defining new types. With some good programming-style conventions, however, and perhaps a bit of manual preprocessing of the source code, a fairly good approximation can be achieved.

How shall we implement a complex-number package? Let us define a Pascal type called COMPLEX as a record with real and imaginary components:

```
type COMPLEX =
  record REALPART: real;
         IMAGPART: real
  end;
```

We could then declare variables of type COMPLEX:

```
var A, B, C, D, E, F: COMPLEX;
```

and set A, B, and C as follows:

```
A.REALPART := 1.5; A.IMAGPART := -3.7;
B.REALPART := 2.0; B.IMAGPART := -5.1;
C.REALPART := 0.0; C.IMAGPART := 4.1
```

How shall we do arithmetic on complex numbers? Suppose we defined a procedure:

```
procedure CADD(C1, C2: COMPLEX; var
RESULT: COMPLEX)
```

The complex sum RESULT is a complex number that gives:

```
RESULT.REALPART := C1.REALPART +
C2.REALPART;
RESULT.IMAGPART := C1.IMAGPART +
C2.IMAGPART
```

Writing this procedure would be quite straightforward, and we could do the equivalent of saying $D = A + B$ by writing:

```
CADD(A,B,D)
```

Things start looking messier when we try to emulate a more complicated expression like $D = A + B + C$. We would then have to write something like:

```
CADD(A,B,E); CADD(C,E,D)
```

As the expression gets longer, we need more separate calls to the CADD procedure, each doing only a single operation. It would be better if we could write an *expression*, as we would if we were dealing with integers or real numbers. In other words, can we turn CADD into a *function*, then write:

```
D := CADD(A, CADD(B,C))
```

which is much cleaner (especially in longer expressions)?

Writing functions to do this operation, and others like difference, product, quotient, etc, would be easy if our Pascal functions looked like:

```
function CADD (C1, C2 : COMPLEX) : COMPLEX
```

that is, if functions could return complex numbers as value. Pascal sets up an obstacle here: functions can return only *scalar* types, and COMPLEX is a *structured* type, a record. What can we do?

Enter the Pointer

What is a pointer? It is an abstraction of the idea "the data at the address: ..." Pointers exist in many programming languages, notably PL/I. A pointer in Pascal is written in publication language as ↑. Since many implementations use the symbol @ instead, we shall use it as well.

In Pascal, you can declare a variable to be a pointer:

```
var P: @INTEGER
```

which is read "P is a pointer to an integer." Pascal, differing from PL/I, for example, requires not only a declaration of all pointers, but also a declaration of the type of thing pointed to. This is a protection against using pointers indiscriminately to point to different things at different times and is a reflection of the Pascal "strong-typing" philosophy. P@ is read "the thing pointed to by P."

Pointers must be used with care. In fact, it is often said that "pointers are to data what GOTOs are to program code." But in appropriate situations, pointers in Pascal are extremely useful.

Pascal textbooks illustrate pointers as a way to link nodes in a list or tree structure, and many of you are familiar with this application. What is not usually discussed in the texts is, first, that pointers don't have to be used as that kind of link, and second, that pointers are scalar types, and thus may be returned as function values.

Listing 1: *Pascal programming examples (see the text for details).*

(1a)

```
type COMPNUM =
  record
        REALPART, IMAGPART: real
  end;
        COMPLEX = @COMPNUM
```

(1b)

```
function MAKECOMP (R,I: real): COMPLEX;
var P: COMPLEX;
begin NEW (P);
        P@.REALPART := R; P;. IMAGPART := I;
        MAKECOMP := P
end;
```

(1c)

```
function RE( C: COMPLEX): real;
  begin RE := C@.REALPART end;
function IM( C: COMPLEX): real;
  begin IM := C@.IMAGPART end;
```

(1d)

```
function CSUM ( X,Y : COMPLEX): COMPLEX;
  begin
        CSUM := MAKECOMP (RE(X) + RE(Y), IM(X) + IM(Y))
  end;
```

(1e)

```
function CEQUALS ( X,Y: COMPLEX ): Boolean;
  begin
        CEQUALS := RE(X) = RE(Y) & IM(X) = IM(Y)
  end;
```

(1f)

```
type COMPNUM =
  record
        REALPART, IMAGPART: real;
        TEMPORARY: Boolean
  end;
```

(1g)

```
function MAKECOMP (R, I: real): COMPLEX;
  var P: COMPLEX;
  begin NEW(P);
        P@.REALPART   := R;
        P@.IMAGPART   := I;
        P@.TEMPORARY:= TRUE;
        MAKECOMP      := P
  end;
```

We can use pointers advantageously in creating our package for complex numbers. Instead of using the type COMPLEX to name our complex-number record, let us rename that record COMPNUM and use COMPLEX to refer to a pointer to a COMPNUM, as shown in listing 1a. Declaring variables as in:

var A, B, C, D, E, F : COMPLEX

does not create six records—only six pointers. The records come into being later.

We can give a calling program an easy way to create a complex number by noticing that the Pascal predeclared function NEW can be used to create instances of a type at execution time. A call such as NEW(P), where P is a pointer to some type, creates space for an instance of that type, returning the location of the new instance in P. We can now write a Pascal function MAKECOMP, as in listing 1b.

MAKECOMP creates a new complex number with real and imaginary parts and returns a pointer to that new number as its value. A user can then write:

A := MAKECOMP(2.0, −5.5)

and, assuming that A is of type COMPLEX, never realize what is going on at the lower level.

We can further insulate the user from the "dot" notation of Pascal records and any concern with pointers by writing two functions that access the real and imaginary components (see listing 1c). Given that Y is of type real, Y := RE(A) looks much like the corresponding notation from mathematics.

At this point, we can start writing other functions to do complex arithmetic. All such functions can now be written with arguments and return values of type COMPLEX, and no further reference must ever be made to lower-level implementation details. For example, see the code for CSUM in listing 1d. A function to determine if two complex numbers are equal might be written as in listing 1e.

Giving Back the Memory

This would all work very well, except for one problem. If we were to write the complex-expression equivalent of:

$$E = (A \times B) + (C \times D)$$

[E:= CSUM(CPROD(A,B),CPROD(C,D))]

our scheme would call NEW to get space for the *temporary* results CPROD(A,B) and CPROD(C,D), as well as for the final sum of the two. What happens to the two temporary records we created?

They remain allocated and will not be reused. Continual use of expressions like this will allocate temporary space that will not be recovered. Eventually, our program will run out of dynamic-memory space (usually called *heap* space) and "bomb," even though we're not actually using all that space.

(1h)

```
procedure CASSIGN (var C1, C2: COMPLEX);
  begin
        if C1 < > nil then DISPOSE(C1);
          (* if C1 already points to something *)
          C1 := MAKECOMP(RE(C2), IM(C2));
          C1@.TEMPORARY := FALSE
  end;
procedure CRELEASE (C1: COMPLEX);
  begin
        if C1@.TEMPORARY then DISPOSE(C1)
  end;
```

(1i)

```
function CSUM(X,Y: COMPLEX): COMPLEX;
  begin
        CSUM := MAKECOMP(RE(X) + RE(Y), IM(X) + IM(Y));
        CRELEASE(X); CRELEASE(Y)
  end;
```

Pascal, in most reasonable implementations, has a built-in function DISPOSE(P) that, given a pointer P, returns whatever is pointed to by P to the heap. It's the inverse of NEW. The problem is for our system to be able to discern whether a given complex is temporary, as in the intermediate expressions above, or permanent, like A, B, C, D, and E.

One way to do this is to add to each record a Boolean field TEMPORARY that is set to TRUE by MAKECOMP. This changes the declaration of COMPNUM to that shown in listing 1f. It also changes the MAKECOMP function to that shown in listing 1g. Two questions remain: how to designate permanent complex numbers, and how to DISPOSE of temporary ones.

The first question is answered by noticing that the only time we need a permanent complex number is when we are assigning it to a declared variable. To do this, we write a procedure CASSIGN(C1, C2), which copies C2 into C1, replacing the assignment (:=) operation and setting TEMPORARY to false.

To dispose of temporary structures, we can write a procedure CRELEASE(C) that calls DISPOSE if C is temporary. We have to call CRELEASE in each of our arithmetic functions so input arguments to these functions can be given back, if temporary. The CASSIGN and CRELEASE procedures are seen in listing 1h.

This may be messy. But since Pascal will not "collect the garbage" automatically, it's about the only way to reclaim the storage. As an example of where to use CRELEASE, consider the revised CSUM in listing 1i. A typical assignment statement might be:

CASSIGN(A, CSUM(B, CPROD(C,D)))

which is equivalent to A = B + C × D.

We could go on and on, but you can fill in further details. We can summarize by reiterating that choice of a good implementation strategy (pointers and records) and the right low-level primitive functions (MAKECOMP, RE, IM) has given us a healthy level of insulation for higher-level programs from messy details. Even fundamental operations like sum and equals can be written using the notations of the application area, rather than the esoterica of the programming language.

An objection could be made that we are paying a price in run-time efficiency by insisting on all these levels of insulation, each imposing either a subprogram call (and its overhead) or an indirect (pointer) reference (also with an associated overhead). There is no doubt that a price measured in machine performance is exacted here. We counter by pointing out that almost any device used in programming to increase *people* efficiency (and this includes high-level languages) takes its toll in reduced machine performance. In today's world of fast and inexpensive hardware, it's a price worth paying.

The Specification Part

The routines shown previously constitute part of what is usually called the *package body*, namely, the implementing code for all the routines. Ideally, we should be able to write a section giving only functional specifications, and this would be the only part visible to a user or calling program.

Listing 2: *The specification part of a* package *that states the complex-number data type. It is included in the Pascal program as a comment and explains what the attributes of the package are, but not necessarily how they work.*

```
(* package ComplexNumbers
   type COMPLEX                                    details private
   function MAKECOMP ( R,I : real )                  : COMPLEX;
   function RE ( C : COMPLEX )                       : real;
   function IM ( C : COMPLEX )                       : real;
   function CSUM ( X,Y : COMPLEX )                   : COMPLEX;
   function CDIFF ( X,Y : COMPLEX )                  : COMPLEX;
   function CPROD ( X,Y : COMPLEX )                  : COMPLEX;
   function CQUOT ( X,Y : COMPLEX )                  : COMPLEX;
   function CEQUALS ( X,Y : COMPLEX )                : Boolean;
   function CLESSEQ ( X,Y : COMPLEX )                : Boolean;
   function CGTREQ ( X,Y : COMPLEX )                 : Boolean;
   ...and possibly some complex I/O routines. *)
```

Listing 3: *A complex-number package written for the Pascal-like language Ada.*

```
function "*" (x,y: complex) return complex is
   R,I: float;
   begin
         R := RE(x)*RE(y) - IM(x)*IM(y);
         I := RE(x)*IM(y) + IM(x)*RE(y);
         return (R,I);
   end;
function "*" (x: float; y: complex) return complex is
   TEMP : complex;
   begin
         TEMP := (x * RE(y), x * IM(y));
         return TEMP;
   end;
```

Since Pascal has no facility for separating these two important sections, we shall write the specification part as a block comment. A specification part for complex numbers is shown in listing 2.

Operator Overloading

In writing our complex-number package in Pascal, we were forced to use prefix-function notation (ie: CSUM(X,Y), and so on). Ideally, a higher-level program should be able to write $X + Y$ when $X + Y$ is meant, and the compiler should be able to invoke the addition routine appropriate to the declared types of X and Y. Suppose, for example, that X and Y were vectors of integers. If we had written a routine to add two vectors, there ought to be some way to inform the compiler that vector addition is what is meant by $X + Y$ if X and Y are declared as vectors. In other words, instead of calling our complex-addition routine CSUM, we should be able to call it +, and let the compiler determine when its use is appropriate.

To give an example of how this *can* be done in Ada, here are two functions, both called *, to do complex multiplication and multiplication of a complex by a real scalar (see listing 3).

The two most important parts of this example are the two additional operators named *—the compiler can tell which one is meant, in an expression, by the types of the operands—and the fact that in Ada, unlike Pascal, structures can be returned as function values. The pointer scheme used in this article is thus unnecessary in Ada.

This technique of adding power to an arithmetic operation, extending its range to cover new data types, is known as *operator overloading*. Several experimental languages have supported overloading; SNOBOL4 is a major language in the "real world" that has supported it for more than ten years. But no widely used procedural language permits operator overloading. As the Ada language comes into wide use, many people will discover and appreciate its overloading facility, as well as other niceties that make packages easy to do.■

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A Voice for the Apple II Without Extra Hardware

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With an Apple II computer and a standard cassette-tape player, I have been able to store human voices in digital form and recall them later with relatively good fidelity. In fact, my 48 K-byte Apple computer can store up to three minutes of digital voice data without additional hardware or disk storage.

My experiments in this area began after reading other articles concerning the application of home computers to voice recording (see reference). These prompted me to try simple hardware additions to a standard Apple computer and to experiment with various low-priced A/D (analog-to-digital) converters that were readily available from local electronics supply houses.

The problems I encountered fell into three general categories: first, most inexpensive A/D converters will not operate in the range of 10,000 to 12,000 samples per second. This is the minimum rate acceptable for reasonable word reproduction. Second, at higher sample rates the computer memory required to store the digital data exceeds the memory of the Apple computer after only a few seconds of actual operation. And finally, the hardware I was adding to the computer tended to be cumbersome and of relatively low quality. I would have to overcome each of these problems before I could store voices in my computer.

Recording the Voice

The idea for recording voice *without* additional hardware came from looking at commercially available software that digitizes voice input to the Apple computer from a standard cassette-tape recorder through the cassette-input port. It is possible to monitor zero crossings of any analog signal, including voice, simply by making a recording of the signal on a cassette tape, then plugging the recorder into the Apple cassette-input port and playing the tape back while monitoring memory location C060 (hexadecimal), bit 7 (cassette input). Above a certain level of input signal, the cassette input will read high; below this level it will read low. The level of this transition is called the *threshold*.

If voice is thought of as being a simple sinusoidal function, it is readily apparent that each time the signal crosses the threshold, the state of the cassette-input bit changes. A history of these changes contains all of the frequency characteristics of the original analog input, assuming two threshold crossings per cycle. Since this method of data gathering really amounts to a 1-bit A/D conversion, amplitude information is not present and the stored voice will be reproduced at a constant volume depending on the hardware used for the actual playback.

It should also be noted at this time that the sampling rate must meet the Nyquist criteria. That is, the rate at which the cassette-input port is read must be equal to at least twice the frequency of the highest voice harmonic that we wish to store.

The ideal cassette recorder should have a volume and a tone control so that the user can input the correct amplitude and control the frequency range to reproduce a given voice with minimal noise and to cause the midpoint of the input signal's peak-to-peak amplitude to be set at the point where the Apple threshold ("0" to "1" transition) occurs. The quality of speech recorded will vary dramatically with changes in these parameters, and each individual will have to find the correct settings by experimentation. For my own voice and cassette recorder, I use relatively low volume settings with the tone control adjusted to its highest frequency.

Data Compression

At this point, by using the cassette input for data, I had solved the problems of not being able to find inexpensive A/D converters that could sample at a fast enough rate to record voice and of having to add wires and power supplies to my Apple computer. However, once I learned how to record voice and store it in memory, I found that about twenty seconds of data were all I could handle. This was the result of packing 8 bits of A/D data into each memory location.

On close inspection I found that the data that had been stored did not always change from sample to sample. This was true when low-frequency signals were being input and also during the times when no input was being sensed at the cassette-input port (eg: when the speaker stops to breathe, or at the beginning of a recording before the speaker has started talking). Since the data fluctuations had this characteristic, I decided to store data such that the first bit of each memory location represented the status of the A/D input and the next 7 bits represented a counter indicating the number of samples collected while that input remained unchanged. If the counter overflowed the alloted 7 bits, the same A/D bit would be stored in the next memory location with a new counter value.

Listing 1 is written in 6502 machine language and should load voice data into any Apple computer with 48 K bytes of memory. For machines with less memory, the operands in statements 849 and 810 (hexadecimal) can be changed to a smaller hexadecimal number representing the most-significant byte of the upper limit of memory.

At this point I had a computer memory full of A/D data that contained enough samples to reproduce between one and three minutes of reasonably understandable human voice. The exact time of playback is a function of voice pitch and the setting of the inputs on the tape recorder. Also, certain sounds such as "sssss" tend to cause a great deal of change in the A/D data relative to the sampling rate and will therefore give less voice recording time for a given amount of memory.

Although it is difficult to analyze the efficiency of this new A/D packing technique by data inspection, I assume that it is five to six times more efficient than the method of packing 8 bits per word. I base this conclusion on the improvement in time for a given memory size. Reproducing the voice data for playback was the next logical experimental step.

Reproducing the Voice

The Apple computer has an onboard speaker that can be toggled by a read or a write to memory location C030 (hexadecimal). The software shown in listing 2 will unpack the stored A/D data and toggle the speaker each time that the data counter reaches zero and the A/D bit changes state. This amounts to producing a "click" on the output speaker each time the original input voice signal had a zero crossing.

It may be hard to imagine how these clicks can reconstruct the human voice since they have no tones or amplitudes related to the original voice input. Try not to think about the individual clicks; instead, think of a series of clicks being output at a varying frequency which is a function of the original voice input. This varying frequency is an FM (frequency modulated) reproduction of that original input signal.

Although the reproduced signal is understandable if output in the above manner, there are several significant sources of noise that degrade the voice, one being the Apple's on-board speaker itself. The others relate to the method of sampling and reproducing the data. To reproduce any analog signal stored in digital format, it is very important to sample the A/D converter at a constant rate and to make the corresponding D/A (digital-to-analog) conversion at that same uniform rate. Any variance of these rates will cause high noise levels that will have to be filtered.

Unfortunately, the software that I had written to sample the input data had several different logical paths to follow depending on whether the counter was being incremented or whether it plus the data bit were being stored, and whether the least- or most-significant bit of the storage location had to be incremented. Each case took a different number of machine cycles to complete and therefore affected the time required to return and read the cassette-input port. When I modified the software to make each logical path use the same number of machine cycles, what I was really doing was slowing down each logical loop until they all ran at the rate of the slowest loop. This had the undesired effect of lowering the sample rate and reducing the bandwidth of the input signal, which at-

Listing 1: *A/D input routine. Record your voice input on the cassette tape, then run the tape while executing this program starting at location 800 (800G). Voice data will be stored from location 1000 through BFFF in the form of data plus counter. Adjust the number at location 81F to change the sample rate of the A/D converter. The lower the number, the better the quality, but less time will be available for a given amount of memory.*

```
800  A9 00     LDA #$00
802  8D 00 10  STA $1000    Store zero
805  EE 03 08  INC $0803    Increment storage LSB
808  D0 F8     BNE $0802
80A  EE 04 08  INC $0804    Increment storage MSB
80D  AD 04 08  LDA $0804
810  C9 C0     CMP #$C0     Check for end of memory
812  D0 EC     BNE $0800
814  A9 00     LDA #$00     Restore storage LSBs and MSBs
816  8D 03 08  STA $0803
819  A9 10     LDA #$10
81B  8D 04 08  STA $0804
81E  A0 0A     LDY #$0A     Load sample rate delay counter
820  88        DEY
821  D0 FD     BNE $0820
823  AD 60 C0  LDA $C060    Get data from cassette input port
826  29 80     AND #$80     Use only the first bit
828  CD A0 09  CMP $09A0    Compare to previous A/D sample
82B  8D A0 09  STA $09A0    Replace old A/D value with new one
82E  D0 05     BNE $0835    Branch if bit changed state
830  E8        INX          Increment counter
831  E0 7F     CPX #$7F     Compare counter to overflow value
833  D0 E9     BNE $081E    Branch if counter < 127
835  8A        TXA          Move counter to accumulator
836  A2 00     LDX #$00     Zero counter
838  4D A0 09  EOR $09A0    OR bit with counter value
83B  8D 00 10  STA $1000    Store data plus counter
83E  EE 3C 08  INC $083C    Increment storage location
841  D0 DB     BNE $081E
843  EE 3D 08  INC $083D
846  AD 3D 08  LDA $083D
849  C9 C0     CMP #$C0     Check for end of memory
84B  D0 D1     BNE $081E
84D  A9 00     LDA #$00     Restore program locations
84F  8D 3C 08  STA $083C
852  A9 10     LDA #$10
854  8D 3D 08  STA $083D
857  00        BRK          End of storage routine
```

tenuated the higher harmonics to the point where word recognition became extremely difficult.

Two solutions to the above problem were possible: the first was to use digital-filtering techniques on the stored data to remove unwanted noise. I rejected this due to the complexity of designing a bandpass filter which is not symmetrical with respect to a frequency equal to one half of the A/D sampling rate. The design of this type of filter requires the use of complex multiplying coefficients and is not practical for real-time microcomputer operations on large amounts of data.

Instead, I used the hardware filters controlled by the cassette-tape-recorder tone control and sent the data back to the cassette to be either recorded on tape or output in the PA (public address) mode. To do this I changed the output software to toggle memory location C020 (cassette output) instead of the Apple speaker. The results were quite good when using this method to reproduce the stored voice. I used the cassette tone control to filter out unwanted noise.

Just to prove that anyone can understand a voice that had been recorded and then reproduced with the methods I have discussed in this article, I tried recording random passages from several different textbooks and playing them back to different listeners. Most had no trouble understanding the output once I had optimized the sampling rates and tone controls for my own voice.

Future Plans

The next step in my experiments will be to store digitized voice on the computer disk, which should allow approximately ten minutes of playback. I am also trying to find methods of packing voice data into more efficient patterns to minimize memory-size requirements. I hope this article helps others find inexpensive methods of bringing speech to their computers. ■

Reference

Anderson, James C. "An Extremely Low-Cost Computer Voice Response System," February 1981 BYTE, pages 36-43.

Listing 2: *A/D output routine. First store data using listing 1 and a cassette recorder. After the data is stored in the Apple memory, it can be output to the on-board speaker by running this program from location 860 (860G). To send the data back to the cassette-output port, change location 874 to 20 and run the program from location 860 with the tape recorder in either the record or PA mode. The counter in location 877 should be adjusted until the optimal output is found. The number at location 892 is the most-significant byte of the upper limit of memory.*

```
860  AD 01 10  LDA $1001     Get A/D data
863  29 7F     AND #$7F      Mask for counter only
865  AA        TAX           Move counter to X register
866  AD 01 10  LDA $1001     Get A/D data
869  29 80     AND #$80      Mask for data only
86B  CD A0 09  CMP $09A0     Compare to previous data
86E  8D A0 09  STA $09A0     Store current data
871  F0 03     BEQ $0876     Branch if current data = last data
873  8D 30 C0  STA $C030     Toggle output
876  A0 0D     LDY #$0D      Programable delay loop
878  88        DEY
879  D0 FD     BNE $0878
87B  CA        DEX           Decrement A/D counter
87C  30 02     BMI $0880     Used only for initial value of zero
87E  D0 F6     BNE $0876     Branch if A/D counter <> 0
880  EE 61 08  INC $0861     Increment data pointer's LSBs
883  EE 67 08  INC $0867
886  D0 D8     BNE $0860     Test for MSB increment
888  EE 62 08  INC $0862     Increment data pointer's MSBs
88B  EE 68 08  INC $0868
88E  AD 68 08  LDA $0868
891  C9 C0     CMP #$C0      Test for the end of memory
893  D0 CB     BNE $0860     Branch to next sample
895  A9 01     LDA #$01      Restore pointers
897  8D 61 08  STA $0861
89A  8D 67 08  STA $0867
89D  A9 10     LDA #$10
89F  8D 62 08  STA $0862
8A2  8D 68 08  STA $0868
8A5  00        BRK
```

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What's New?

PERIPHERALS

Computer-Driven Typewriter

The Bytewriter operates as a letter-quality printer and as an office typewriter without any attachments. The self-contained mechanism uses electromagnetic actuators to interrupt the motion of a set of levers driven by a Smith-Corona 8000 office typewriter's motor. A microprocessor controls the operation of the Bytewriter and provides an automatic self-test.

The Bytewriter costs $795. For more information, contact Bytewriter, 125 Northview Rd, Ithaca NY 14850, (607) 272-1132.

Circle 501 on inquiry card.

Silentype Thermal Printer

The Silentype thermal printer offers 80-column, draft-quality copy and the ability to print high-resolution graphics. The Silentype can be used with Apple II, II Plus, and III microcomputers. It prints upper- and lowercase text at up to 40 cps (characters per second). Graphics characters are printed at 60 dots per inch. Standard heat-sensitive paper is used instead of aluminized rolls. With the Apple III, type styles can be specified.

The Silentype printer costs $395. For more information, contact Apple Computer Inc, 10260 Bandley Dr, Cupertino CA 95014, (408) 996-1010.

Circle 502 on inquiry card.

IBM or Apple?

The Apple II will soon have available for it an 8088 microprocessor card that will enable it to run software for the 8088/86 family. The 8088 is the same microprocessor used in the new IBM Personal Computer. The MetaCard is a secondary processor card featuring a 5 MHz 8088; 64 K bytes of programmable memory with parity checking, expandable to 128 K; 2 K bytes of ROM (read-only memory), expandable to 8 K; an external bus connector for expansion to 384 K bytes of memory; a real-time clock interrupt for multitasking; provisions for 8087 floating-point support; full-speed concurrent processing by both the 8088 and the Apple's 6502; interrupts in both directions between processors; and access to the Apple's memory by both processors. In most applications when the MetaCard is active, the 6502 will be used as an I/O (input/output) processor.

For software, CP/M-86 will be included. MP/M-86 and UCSD Pascal 4.0 will also be offered for multitasking purposes. The MetaCard can directly address up to one half megabyte of memory. Software that will run under CP/M-86 will run on the MetaCard including software for the IBM Personal Computer. The price for the MetaCard, which will occupy one of the Apple slots, is $980. Contact Metamorphic Microsystems, POB 1541, Boulder CO 80306, (303) 499-6502. Circle 503 on inquiry card.

TRS-80 Model III Light Pen

The 3G Light Pen lets you bypass the TRS-80 Model III's keyboard and act directly on the information on the video display. It is fully assembled and comes with a demonstration game cassette, sample program, and manual. The pen sells for $39.95 and is available from 3G Company Inc, Rt 3, Box 28A, Gaston OR 97119, (503) 662-4492.

Circle 577 on inquiry card.

Inexpensive Modem

The Model 1080 VersaModem offers the ability to converse with information utilities such as The Source, CompuServe, Dow Jones, computerized bulletin boards, and university computers. The direct-connect VersaModem operates at 300 bps (bits per second) using Bell standard 103 protocol and connects to your terminal or computer through an RS-232C serial port. The VersaModem costs $119. For details, contact Bizcomp Corporation, POB 7498, Menlo Park CA 94025, (415) 966-1545.

Circle 504 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.

What's New?

PERIPHERALS

Tractor-Feed Conversion

The Model 16 Fanfold Feeder allows continuous-form paper to be used with IBM Selectrics and other typewriters or printers. It maintains continuous-form alignment, installs easily, and requires no electrical or mechanical connections. The adjustable-width tractors accept form widths of up to 16½ inches and can be used with single- or multiple-part forms. The price for the Model 16 Fanfold Feeder is $149.95. Contact McAnn Company, POB 3173, San Mateo CA 94403, (415) 349-1229.

Circle 505 on inquiry card.

12-Inch Green-Phosphor Monitor

The Video-300 monitor features a 12-inch screen, 18 MHz bandwidth, and a resolution of 1000 scan lines at the center and 800 at the corner. Its green-phosphor display cuts down annoying reflection and glare. The monitor weighs 17 pounds and measures 29 by 37 by 34 cm (11⅗ by 14½ by 13⅗ inches). The suggested retail price for the Video-300 monitor is $249 from Amdek Corporation, 2420 E Oakton St, Suite E, Arlington Heights IL 60005, (312) 364-1180. Amdek was formerly known as Leedex Corporation.

Circle 507 on inquiry card.

Expand the TRS-80

The MDX-1 and -2 expansion interface boards are hardware- and software-compatible with the TRS-80 Model I computer. They feature 32 K bytes of memory expansion, provisions for a 2 K- or 4 K-byte EPROM (erasable programmable read-only memory), a direct-connect, 300-bit-per-second modem, a serial port, a parallel port, a dual-cassette option, and hardware for a real-time clock. The MDX-2 also has a floppy-disk controller. The MDX-2 bare board costs $74.95, and the MDX-1 costs $64.95. Manuals are $5.95. Parts kits and cabinets are available. Contact Micro-Design, POB 748, Manchaca TX 78652, (512) 282-0225.

Circle 509 on inquiry card.

TRS-80 Telecommunications

The Connection offers telecommunications capabilities on Model I TRS-80s with or without an expansion interface. This direct-connect modem eliminates noise and data loss or distortion. The unit features an RS-232C I/O (input/output) port and runs at 300 bps (bits per second) in duplex or simplex modes. It can be connected to two-way radios and can provide computer-to-computer communications over the air. Software, documentation, a list of on-line bulletin boards, and operating procedures are included with the Connection. It is available for $249 from the Microperipheral Corporation, 2643 151st Pl NE, Redmond WA 98052, (206) 881-7544.

Circle 506 on inquiry card.

1200 BPS Direct-Connect Modem

The CM2020 is a 1200-bit-per-second single-card modem that saves valuable workspace because it measures only 30 square inches. Using a microprocessor-based design, auto-dialing, self-testing, and auto-answering are made available on the modem. Other features include self-testing or testing via the terminal, frequency-sensitive carrier-detect circuitry that will not trigger data-carrier detect unless there is true in-band carrier energy present, Bell 202S-compatibility, and selectable call origination that supports auto-dialing, dial-through, and conventional dialing. The CM2020 modem costs $200, in 50-unit lots. For details, contact Intertel, 6 Shattuck Rd, Andover MA 01810, (617) 681-0600.

Circle 508 on inquiry card.

Epson MX-100

The 136-column MX-100 dot-matrix printer uses matrices that range from 9 by 9 to 18 by 18 dots. It can print 12 different character weights and sizes. The printer also features Epson's disposable print head and GRAFTRAX, a high-resolution bit-image graphics capability. Using paper 15½ inches wide, the MX-100 can print up to 233 columns in the condensed-print mode. Bidirectional printing at 80 cps (characters per second) can be accomplished by using its logic-seeking function.

The printer comes with a friction paper feed and adjustable tractors on a removable tractor mechanism. The suggested retail price for the MX-100 is $995. For details, contact Epson America Inc, 23844 Hawthorne Blvd, Torrance CA 90505, (213) 378-2220.

Circle 510 on inquiry card.

What's New?

PERIPHERALS

High-Resolution Light Pen for the Apple

The LPS II light pen makes use of the Apple II's 280- by 192-pixel resolution. Applications such as computer-aided design, menu selection, graphics, circuit analysis, word processing, and game playing can benefit from the LPS II. It is compatible with all available languages. It works at a 60 Hz rate, which allows true animation and drawing. When the video beam passes on the screen, the LPS II uses video-synchronization information to determine the pen's location. The LPS II is available for $285 from Gibson Laboratories, Bldg 10, 406 Orange Blossom, Irvine CA 92714, (714) 559-8727.

Circle 511 on inquiry card.

Housing for Disk Drives and Video Display

The Super Card Cage V1 includes a four-slot Multibus motherboard and space for mounting two 8-inch floppy-disk drives, a video monitor, a switching power supply, and a separate keyboard enclosure. The unit is predrilled for a fan, connectors, fuse, power cord, and power switch. Optional configurations accommodate up to six Multibus cards or a six-slot S-100 bus, an eight-slot Q-BUS, or twelve-slot STD-BUS motherboards. The Super Card Cage V1 costs $495. Contact Psytek Inc, 1900 Pickwick Ave, Glenview IL 60025, (312) 729-3200.

Circle 513 on inquiry card.

Tractor-to-Friction-Feed Conversion

The Paper Tractor enables a tractor-feed printer to print with single-sheet paper. The device is made of sheet plastic into which standard or letterhead paper is inserted. The Paper Tractor is then fed into the tractor-feed printer, where it carries the paper into the print area. It can be used on front-, back-, and dual-tractor-feed printers and with Epson, Paper Tiger, GP-80M, and other popular printers. The device sells for $19.50 and is available from Paper Tractor, POB 4218, Santa Barbara CA 93103, (800) 235-6967; in California (805) 966-5448.

Circle 515 on inquiry card.

2-Megabyte 5-Inch Floppy-Disk Drives

The Megafloppy 1117 family of floppy-disk drives offers up to 2 megabytes of storage in a single 5-inch drive. There are two single- and two double-sided drives using 96- or 100-track-per-inch double-track technologies in this family of floppy-disk drives. Data-recording density is 12,000 bits per inch. The 1117 provides 6 ms track-to-track positioning speed with transfer rates of 600,000 bps (bits per second). The drives are compatible with industry-standard interfaces, mounting dimensions, and bezels. Double-sided models provide 2.175 and 2.025 megabytes of formatted storage, and single-sided versions offer 1.2 and 1.1125 megabytes. For pricing and availability, contact Micropolis Corporation, 21329 Nordhoff St, Chatsworth CA 91311, (213) 709-3300.

Circle 512 on inquiry card.

Plug-A-Bubble

The Plug-A-Bubble system features removable bubble-memory cassettes designed for harsh environments or critical data-storage applications. The system consists of a 128 K-byte bubble-memory cassette and holder. A chassis, containing two holders and an interface card, fits in the same space as a 5-inch floppy-disk drive. The cassette and holder can be designed to interface with any system.

Each Plug-A-Bubble cassette has a 48 ms average access time and requires +5 and +12 V at 8 W for operation. Also available is a development kit that includes the bubble circuits, a prototyping board, and instructions for designing bubble systems. For information about memory-system products, contact Intel Corporation, 1302 N Mathilda Ave, Sunnyvale CA 94086, (800) 538-1876; in California (408) 734-8102.

Circle 514 on inquiry card.

Graphics and Photography System

The Professional Graphics System can generate graphics on large-screen televisions. Also, it can perform video titling and graphics on tape or simulate a General Electric Genegraphics system for the production of 4- by 5-inch transparencies, 35 mm slides, or Polaroid prints using the screen printer from Image Resource Corporation of Palo Alto, California. Professional Graphics can transfer any display from an Apple II's high-resolution screen and output it as full NTSC (National Television Standard Code) video with interlace and meet SEMPTE (a time code broadcasting standard) criteria.

The Professional Graphics System runs on a 48 K-byte Apple II or Apple II Plus, with a disk drive. It costs $2950. Contact Symtec, 15933 W Eight Mile Rd, Detroit MI 48235, (313) 272-2950.

Circle 516 on inquiry card.

What's New?

SOFTWARE

More FORTH

Nautilus Systems is marketing a cross-compiler progam for FORTH. It automatically forward references any word or label. It can produce headerless code and ROMable (read-only memory) code with initialized variables. This cross-compiler has a load map as well as a full list of undefined symbols.

Machine-readable versions of the cross-compiler program are available for CP/M, TRS-80 Model I, Heath H-89, and North Star computers. Each includes an executable version of fig-FORTH 1.0, the cross-compiler source code, and documentation. The price for the program is $200 from Nautilus Systems, POB 1098, Santa Cruz CA 95061, (408) 475-7461.

Circle 517 on inquiry card.

VT-100 Terminal Emulator Program

ABT VT-100 is a Pascal program that uses the Videx 80-column card and the Apple communications card to emulate a Digital Equipment Corporation VT-100 terminal. It recognizes all the ANSI (American National Standards Institute) and VT-52 escape sequences. When used with Apple Pascal, this program can transmit Pascal text files from the Apple to another computer. Not all of the VT-100 features are offered.

The ABT VT-100 program costs $495. For more information, contact Advanced Business Technology Inc, 12333 Saratoga-Sunnyvale Rd, Saratoga CA 95070, (408) 446-2013.

Circle 519 on inquiry card.

Custom-Design Your Own Character Sets

The Code Works has two programs to help Atari users design their own character sets. With the Fontedit program, users can create the Russian alphabet, APL characters, or special-purpose graphics symbols. Together with Fontedit, the Knotwork program assists users in designing patterns of Celtic Interlace, a technique used by seventh-century Irish monks to illustrate manuscripts. Both programs run on Atari microcomputers. They are available together for $15.95 on cassette or $18.95 on disk. Contact the Code Works, POB 550, Goleta CA 93116, (805) 683-1585.

Circle 521 on inquiry card.

Software for the TRS-80 Voice Synthesizer

SAYIT is a program for TRS-80 Model I Level II computers with or without disk drives. SAYIT allows the Radio Shack Voice Synthesizer to add voice output to BASIC programs. SAYIT adds a SAY command to BASIC that makes the synthesizer speak string or numeric expressions or a combination of the two. Arithmetic expressions are also correctly verbalized. Phonetic spelling can be used to make difficult words intelligible. A talking keyboard feature echoes each key struck and can be switched on or off from BASIC. The program can also be used in experiments using the International Phonetic Alphabet and phonetic strings. SAYIT costs $125, including a manual. Contact Baysik Speech, Suite 289, 1259 El Camino Real, Menlo Park CA 94025.

Circle 518 on inquiry card.

WordStar for Z-89

The WordStar word-processing program is now available for the Zenith Model Z-89 microcomputers. WordStar allows users to print and edit simultaneously and has a tab feature that automatically lines up decimal points in columns. A hyphen-help feature asks users whether to insert a hyphen at the end of certain lines. Boldface, double strike, strikeout, subscript, superscript, overprint, and accent entry commands are also included. WordStar can interrupt itself, execute another program, and return. It will run on CP/M-based Z-89 or Heath H-89 computers with 48 K bytes of memory, but the simultaneous printing and editing feature requires 64 K bytes. The price for WordStar is $395. Contact your Heath/Zenith dealer or write Zenith Data Systems, 1000 Milwaukee Ave, Glenview IL 60025, (312) 391-8181.

Circle 520 on inquiry card.

Electronic Mail for Apple Users

Micro-Courier allows Apple II owners to transmit data to other computers over telephone lines. Transmissions can be sent automatically at a cost of less than $0.25 for 1000 words of text. The system also maintains telephone lists and sorts messages by individual users. Micro-Courier costs $250.

Micro-Telegram allows Apple users to access Western Union services and to send and receive teletypewriter exchange, Telex, and international cables. Apple users can access stock, foreign exchange, gold, and futures information, as well as sports reports and ski conditions from the Western Union data base. Micro-Telegram costs $250. For more details, contact Microcom, 89 State St, Boston MA 02109, (617) 367-6362.

Circle 522 on inquiry card.

What's New?

SOFTWARE

The Micro Link

The Micro Link program lets computer users communicate with each other over telephone lines. Files can be prepared in advance and transmitted automatically. The program features a word-wrapped display fitted to any screen width. The Micro Link can scan The Source, data bases, and computerized bulletin-board systems and record segments of the displays. The Micro Link can serve as a host for another computer or a terminal, so it only needs to be present at one end. The program supports originate and answer modes, full- and half-duplex, and operates at standard data rates. Files can be transmitted in character-, line-, or memory-block protocol. To run, Micro Link needs a Z80- or 8080-based computer with a serial port and modem, 16 K bytes of programmable memory, and the Micropolis disk operating system or CP/M 1.4. The program comes on 16-sector, 5- or 8-inch disks. The price is $89 from Wordcraft, c/o Microcomputer Software Associates, 1122 B St, Hayward CA 94541, (415) 534-2212.

Circle 523 on inquiry card.

FORTH for OSI

S-FORTH is a full implementation of fig-FORTH that runs on all Ohio Scientific (OSI) disk-based computers, from the C1P to the C3. It includes an editor, a virtual-memory disk subsystem, and compatibility with OS65D commands.

S-FORTH is available on either 5- or 8-inch floppy disks for $34.95 or for $49.95 including the source listing. Contact Aurora Software Associates, POB 99553, Cleveland OH 44199, (216) 221-6981.

Circle 524 on inquiry card.

Program for Property Brokers

The Income Property Analysis System (IPAS) is a system of programs for investors, syndicators, and brokers of income properties. With IPAS, the before- and after-tax cash flows of income properties can be analyzed. Provisions are made for handling multiple notes with straight or negative amortization, interest-only notes, or wraparound notes. The program can also be used to analyze rates of return for income property that is already owned. A separate program allows the investor to project after-tax rates of return for up to 10 years, using individual inflation rates for income, expenses, and appreciation of the property value.

The IPAS runs on a TRS-80 Model I or Model III with at least one disk drive and 32 K bytes of memory. The price is $225. A manual can be purchased separately for $5. For details, contact Advanced Business Microsystems, 5801 Marvin D Love Fwy, Suite 103, Dallas TX 75237, (214) 339-2109.

Circle 525 on inquiry card.

Automatic Graphing of Functions

Automatic Graphing of Functions lets users graph equations in the form $y = mx + b$ and $y = f(x)$. It can graph formulas, multiple equations, summation, sine, cosine, and more. The axis is automatically scaled for the size of the screen display. The program has manual or automatic range selection. It is available for the TRS-80 Model I Level II and the Model III. The cassette and manual cost $19.95 from David L Modney, 4144 N Via Villas, Tucson AZ 85719.

Circle 526 on inquiry card.

Telecommunications for the AIM-65

The MDA 2.2 program allows the AIM-65 to function as a full-duplex terminal for communication with a timesharing system or host computer. Utilities are provided for saving and loading BASIC programs or object files through the terminal simulator at speeds up to 2400 bps (bits per second). MDA 2.2 is available in EPROM (erasable programmable read-only memory) along with a source-code listing and manual for $50. Contact Thorson Engineering Company, 6225 76th St S E, Snohomish WA 98290, (206) 334-4214.

Circle 527 on inquiry card.

Dial-Up Software for Your Apple

Online will allow you to call your computer while you're away from home or let your computer take messages in the form of a private message system. It requires a 48 K-byte Apple II Plus with the Hayes Micromodem and at least one disk drive. Up to 50 user accounts, which require an account number and a password for log-in, can be set up. A guest account can also be arranged. Each account can be assigned different priority levels that determine which features or areas of the system may be accessed by that account. This makes Online useful for clubs or businesses that pass many messages and need privacy and security. The program handles mail between accounts and supports auto reply, read again, and delete modes. Online costs $89.95 from Southwestern Data Systems, POB 582, Santee CA 92071, (714) 562-3670.

Circle 528 on inquiry card.

What's New?

SYSTEMS

Hewlett-Packard's New Business Computer

Hewlett-Packard's new desktop business computer, the HP 125, is designed for business managers and professionals. It is especially useful for financial decision making, planning, and analysis. The HP 125 provides word-processing and management communications capabilities. It can be used as a remote terminal to an HP 3000 network, or it can be connected to a mainframe computer through dual RS-232C ports, at speeds up to 9600 bps (bits per second).

The HP 125 has twin Z80A microprocessors, 64 K bytes of memory, and a separate terminal processor. Most functions are performed by the use of eight "soft keys," whose functions are labeled on the screen. Editing keys are standard on the HP 125, as is the ability to store five pages of displayed information.

The CP/M operating system is employed, and Hewlett-Packard has already created five packages for the system: VisiCalc/125, Graphics/125, Word/125, BASIC/125, and LINK/125. The programs range in price from $125 to $500 and are designed exclusively for businesses and programmers using the HP 125 and CP/M.

There are two HP 125 modules from which to choose: the Model 10 and the Model 20. The Model 10 uses dual 5-inch floppy-disk drives with 500 K bytes of storage. The Model 20 offers 2.4 megabytes of memory on 8-inch disks. Both models can be expanded with additional drives.

The HP 125 systems start at $7460 for the dual 5-inch drives, two RS-232C ports, and an 80-character-per-second thermal printer. Contact the Inquires Manager, Hewlett-Packard, 1507 Page Mill Rd, Palo Alto CA 94304, (415) 857-1501.

Circle 529 on inquiry card.

8086 Boards for the S-100

The Tec-86 is a 16-bit, 8086, S-100 microcomputer system. It includes vectored interrupts, 64 K bytes of dynamic memory (or 32 K bytes of static memory) that are expandable to 1 megabyte, two RS-232C ports, three 8-bit parallel ports, an EPROM (erasable programmable read-only memory) boot for CP/M-86, a double-density floppy-disk controller; dual 8-inch Shugart floppy-disk drives, a metal enclosure, a power supply, and cabling. Software for the Tec-86 includes CP/M-86, Pascal/86, and Microsoft BASIC-86.

The Tec-86 costs $3990. For details, contact Tecmar Inc, 23600 Mercantile Rd, Cleveland OH 44122, (216) 464-7410.

Circle 530 on inquiry card.

What's New?

MISCELLANEOUS

64 K-Byte Memory Card for Apple II

Legend Industries Ltd's 64 K-byte programmable-memory board for the Apple II switches 16 K-byte banks of memory over the Apple's ROM (read-only memory) address space. The board is fully compatible with the Apple Language Card. Refresh signals are taken from the Apple motherboard by removing a 4116 memory circuit and inserting a jumper into the socket. The 4116 is then reinserted onto the 64 K-byte board. The board is priced at $300. For details, contact Legend Industries Ltd, POB 112, Pontiac MI 48056.

Circle 531 on inquiry card.

Dynamic-Memory Evaluation Kit

A 64 K-byte Dynamic RAM Evaluation Kit to aid designers in evaluating the MCM6665 HMOS (high-speed metal-oxide semiconductor) programmable memory is available from Motorola's IC Division. The kit is comprised of ten 200 ns MCM6665L20 integrated circuits, a manual request coupon, two data sheets, a Motorola memory selector guide, and a notebook for the designer, and costs only $150. Contact Motorola IC Division, 3501 Ed Bluestein Blvd, Austin TX 78721, (512) 928-6660.

Circle 533 on inquiry card.

CBASIC/86 for CP/M-86 Systems

CBASIC/86 supports the complete CBASIC language for systems running under CP/M-86. It allows programs written in CBASIC for 8080- and Z80-based systems to be transferred to 8086-based systems without modification. Configured as a CP/M-86 compact-memory model, the system supports a full 64 K bytes of memory for both data and code segments. The suggested retail price is $325 from Compiler Systems Inc, 37 N Auburn Ave, POB 145, Sierra Madre CA 91024, (213) 355-1063.

Circle 535 on inquiry card.

COMMLOG

COMMLOG is designed to work with the Apple II and the Hayes Micromodem II. It transforms the combination into a "smart telephone" that displays approximate long-distance time and charges while you talk. It has a built-in calendar routine for logging the day and date. After a call, the person called, duration, date, time, and charges are logged to the disk. Cumulative charges for the month are displayed. COMMLOG has charge codes for attributing calls to different persons or office divisions. It allows standard or military time, and handles holiday rates. COMMLOG has file-maintenance functions for editing, printing, and initializing an auto-dial directory. The program works on an Apple II with 48 K bytes of memory plus Applesoft in ROM (read-only memory). The cost is $39.95 from Harvey's Space Ship Repair, POB 3478, Las Cruces NM 88003, (505) 522-1482.

Circle 532 on inquiry card.

In-Circuit Emulator for S-100 Bus

The MICE-48 emulator for the 8048 family of single-circuit microcomputers is S-100-bus-compatible. It can emulate Intel, or equivalent 8035, 8039, 8048, 8049, and 8748 parts; National 8040 and 8050 parts; plus CMOS (complementary metal-oxide semiconductor) versions. MICE-48 runs under CP/M and features trace, unlimited number of breakpoints, display/modify of program memory, external programmable memory, registers, input/output ports, and flags. A mapping command allows the user to map program memory to PROM/EPROM (programmable read-only memory/erasable PROM) or to the emulator's memory.

The MICE-80 emulator, supporting software, and an 8048 macroassembler cost $950. Contact Signum Systems, 726 Santa Monica Blvd, 217, Santa Monica CA 90401, (213) 451-5382.

Circle 534 on inquiry card.

Unlimited Storage for Local Networks

Your local Cluster/One Model A microcomputer network for the Apple II can now have virtually unlimited file storage with the addition of the Version 1.1 File Server from Nestar Systems Inc. Version 1.1 includes a real-time clock/calendar, turnkey applications support, new file-access synchronization modes, and support of DOS 3.3 and Apple Pascal 1.1. It offers a 30% increase in disk speed, and allows 80 concurrently open files.

The Network File Server, Version 1.1 is being shipped with all new Cluster/One Model A orders. Current intallations can be upgraded in the field for a one-time fee. Software and hardware supplements to the Server permit a network of up to 65 Apple II computers to access disk memory in 16.5-, 33-, or 66-megabyte increments. For complete details, contact Nestar Systems Inc, 2585 E Bayshore Rd, Palo Alto CA 94303, (415) 493-2223.

Circle 536 on inquiry card.

What's New?

MISCELLANEOUS

Simple Video-Display Timer and Controller

The CRT 5047 preprogrammed video-timer and controller integrated circuit is designed for the video-control function in display terminals. It is especially effective for terminals that use 80 by 24 display formats with a 5 by 7 dot-character matrix, although it can be preprogrammed for other display formats.

The CRT 5047 uses a fixed ROM (read-only memory) program that eliminates the software required to specify the display parameters. A two-integrated-circuit combination of the CRT 5047 and the CRT 8002B-003, a video-display-attributes controller, provides all of the electronics for a video terminal. In 100-unit lots, the CRT 5047 costs $18. For more information, contact Standard Microsystems, 35 Marcus Blvd, Hauppauge NY 11787, (516) 273-3100.

Circle 537 on inquiry card.

FIFO from Programmable Memory

The 8X60 FIFO RAM Controller is an integrated circuit that converts programmable-memory circuits into FIFO (first-in, first-out) buffer memories. With it, two asynchronous systems can be interconnected for buffered-data transfer rates exceeding 8 MHz.

The 8X60 provides up to a 12-bit address to a user-selected programmable memory of the desired data width. FIFO depth is selectable to one of four values: 64, 256, 1024, and 4096. Logic is contained within the 8X60 to eliminate contention between read and write operations. Inputs and outputs are standard TTL (transistor-transistor logic), and all address outputs are tri-state. Specifications and pricing are available from Signetics, 811 E Arques Ave, POB 409, Sunnyvale CA 94086, (408) 739-7700.

Circle 539 on inquiry card.

IEEE-488 Interface for the Apple

The IEEE-488 interface card enables Apple II and Apple II Plus computers to monitor productions lines, record and evaluate data, run test equipment, and interface with any apparatus compatible with the IEEE-488 bus. Voltmeters, spectral analyzers, disk drives, and speech synthesizers can be controlled by this card. Also, it can be used to attach non-IEEE-488-compatible peripherals to the bus. The card can be driven by Applesoft or Integer BASIC or any Apple II-supported language. Up to three cards can be installed in the Apple, allowing control of as many as 42 instruments.

The IEEE-488 card costs less than $500. It is available from Apple Computer Inc, 10260 Bandley Dr, Cupertino CA 95014, (408) 996-1010.

Circle 541 on inquiry card.

Single-Circuit CMOS Microcomputers

The Series 80 family of CMOS (complementary metal-oxide semiconductor) single-circuit microcomputers is composed of four microcomputer circuits, peripheral circuits, and a development-support system. The series operates on ISIS- or CP/M-based systems. Series 80 corresponds to the 8048/8049-type NMOS (n-type MOS) devices. In addition to the 8048/8049 instructions, 13 other instructions are offered, including two types of HALT and three types of FLOAT instructions. Eight instructions implement port moves and indirect-decrement functions.

Among the Series 80 family is a development tool, the MPB800, which is an evaluation board that provides real-time emulation and debugging features. Also, there is the MSM80C48 microprocessor, which offers 1 K bytes of ROM (read-only memory) and 64 bytes of programmable memory, and the MSM80C49, which offers twice the memory contents of the C48. Both units feature a timer/event counter, single-level interrupts, 110 instructions, and operate from 5 V ± 10% supply voltage with full TTL (transistor-transistor logic) compatibility. For more information on these products, contact OKI Semiconductor, 1333 Lawrence Expy, Suite 401, Santa Clara CA 95051, (408) 984-4842.

Circle 540 on inquiry card.

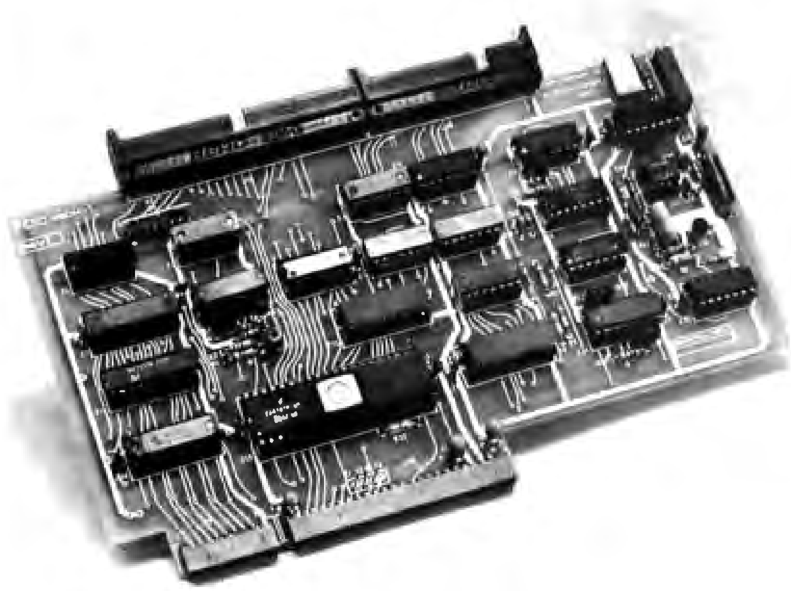
ZX80 Enhancements

Sinclair Research Ltd has an 8 K-byte extended BASIC ROM (read-only memory) and a 16 K-byte programmable memory-expansion module for its ZX80 microcomputer. The extended BASIC features 37 new functions that can be programmed by single key strokes, extended and improved graphics, floating-point arithmetic to 9-digit accuracy, and log and trig functions with their inverses. The BASIC ROM costs $39.95, which includes a new keyboard and a manual. The 16 K-byte expansion plugs onto the back of the ZX80. It costs $99.95. For more information, contact Sinclair Research Ltd, One Sinclair Pl, Nashua NH 03061, or call operator 508 at (800) 543-3000.

Circle 542 on inquiry card.

What's New?

MISCELLANEOUS



Controller Board for Heath Systems

Users can double the 5-inch floppy-disk storage capacity of Heath 88/89 microcomputers with the FDC-880H floppy-disk-controller board from CDR Systems Inc. The board runs under CP/M 2.2 and is capable of handling as many as four Shugart-compatible 5- or 8-inch drives simultaneously. In addition, the FDC-880H handles single- and double-sided operation and single- and double-density data. The board converts 5-inch hard-sectored disks to soft-sectored double-density.

The FDC-880H unit is supplied with a cable, zero-origin conversion PROM (programmable read-only memory), boot PROM with disk diagnostics, and hardware and software manuals. It costs $695 and is available from CDR Systems Inc, 7667 Vickers St, Suite C, San Diego CA 92111, (714) 275-1272.

Circle 543 on inquiry card.

New AMD PROMs

Advanced Micro Devices' (AMD) new family of PROMs (programmable read-only memories) uses a platinum-silicide fuse, which offers a 97% programming yield. Among the family members are the Am27S40 and the Am27S41. Both are 4 K-byte by 4-bit bipolar PROMs. The Am27S40 has open-collector outputs while the Am27S41 has three-state outputs. The devices offer 50 ns or 35 ns maximum access times, respectively. The Am27PS41 is a three-state, power-switched PROM that relieves power problems by reducing consumption from 875 mW to 425 mW when deselected.

The platinum-silicide fuse is normally programmed with a single pulse. There have been no fuse failures reported in more than 13 billion hours of tests.

In 100-unit lots, prices for this family of PROMs begin at $44.90. For more information, contact Advanced Micro Devices Inc, 901 Thompson Pl, Sunnyvale CA 94086, (408) 732-2400.

Circle 544 on inquiry card.

Upgrade Your Casiotone

Robin Whittle, 42 Yeneda St, North Balwyn, Australia, has a technical bulletin that contains extensive yet simple modifications for the Casiotone M-10 keyboard instrument. The M-10 is a hand-held, four-voice synthesizer. With Robin's modifications, the M-10 can have 25 voices, two-octave drop switches, hold, sustain, a milder vibrato than normal, and adjustable tuning. The parts required cost approximately $20. Robin's bulletin, which includes the theory and construction notes, costs $3

Circle 545 on inquiry card.

North-Holland Catalog

Books and journals covering computer communications, simulation, artificial intelligence, programming languages and techniques, computing in medicine and biology, and other related subjects are described in the North-Holland Computer Publications Survey 1980. Many of the publications are papers from conferences and seminars. For the brochure and price list, contact Elsevier/North-Holland–Journals Information Center, 52 Vanderbilt Ave, New York NY 10017, (212) 867-9040.

Circle 546 on inquiry card.

Handbook Explains EEPROM

The E²PROM Family Applications Handbook describes the operation and application possibilities of Intel's 16 k-bit EEPROM (electrically erasable programmable read-only memory). The handbook shows ways to interface the device to a microprocessor and program it. The handbook is available free from Intel Corporation, Literature Department SV3-3, 3065 Bowers Ave, Santa Clara CA 95051, (408) 734-8102.

Circle 547 on inquiry card.

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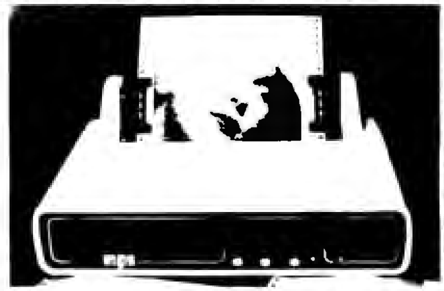

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APPLE SOFTWARE

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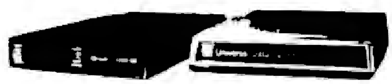

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202 LP *1200 BAUD*	259.
NOVATION CAT, acoustic	159.
D-CAT, *direct*	169.
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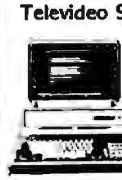
Ampex Dialog 30	795.
Televideo 920C	845.
Televideo 950	995.



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3510/3530 RO	$1,895.
Bi-directional tractor	$225.
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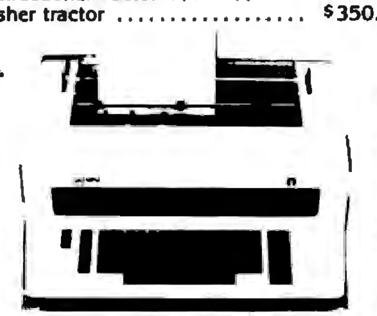
NEW!



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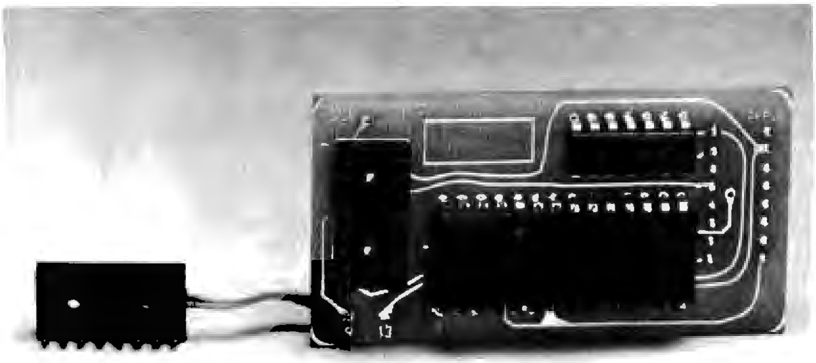
Circle 336 on inquiry card.

What's New?

MISCELLANEOUS



Type-Ahead Buffer

The Model 150 Type-Ahead Buffer for the Apple II features a 40-character type-ahead capability. It eliminates the need to wait for computer prompts before entering the next command or data. No software patches, circuit board cuts, or jumpers are required. The Model 150 costs $49.95 and is available from Vista Computer Company, 1317 E Edinger, Santa Ana CA 92705, (714) 953-0523.

Circle 550 on inquiry card.

64 K-Bit ROM

GTE's 2364 is a 64 K-bit ROM (read-only memory) with an automatic power-down feature that reduces power requirements. The device operates with a 40 mA current in the active mode and an 8 mA current in the standby mode. It uses a single +5 V supply.

The 2364 is organized as an 8 K-byte by 8-bit unit. The device has access times of 250 and 300 ns. All inputs and outputs are TTL- (transistor-transistor logic) compatible.

In lots of 250, the 300 ns 2364 ROM costs $21.20. Contact GTE Microcircuits Division, 2000 W 14th St, Tempe AZ 85281, (602) 968-4431.

Circle 548 on inquiry card.

A Modem for the Atari

The Microconnection is an answer/originate, direct-connect modem for Atari 400 and 800 computers. The Microconnection features autodial/autoanswer operation (optional), which allows an unattended Atari to send messages, text, or other data to a host computer, and automatically answer the telephone and receive data, too.

The Microconnection is Bell 103 compatible and operates at 300 bps (bits per second). Models are available for use without the Atari 850 interface and provide a socket for connection to any serial printer capable of 300 bps operation. A cassette recorder can be plugged into the unit for storage and playback of received data.

With autodialing terminal software, power supply, and a cable, the Microconnection costs $199.50. The autodial/autoanswer option is $79 extra. For complete details, contact the Micro-Peripheral Corporation, 2643 151st Pl, NE, Redmond WA 98052, (206) 881-7544.

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FORTH for the Apple

TransFORTH II is a fully compiled, floating-point implementation of fig-FORTH for Apple II, II Plus, or III microcomputers. It has transcendental functions, strings and arrays, high- and low-resolution graphics, Turtlegraphics, and music.

TransFORTH II has a suggested price of $125. For details, contact Insoft, 259 Barnett Rd, Unit #3, Medford OR 97501, (503) 779-2465.

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Articles and Papers Compilation

The Battelle Memorial Institute has a booklet listing the titles of papers and articles from its staff. The booklet contains the names and dates of the publications in which an article or paper appeared and the author(s).

Copies of the booklet, entitled **Published Papers and Articles: 1980**, are free from the Reprint/Brochure Center, Battelle Memorial Institute, 505 King Ave, Columbus OH 43201, Attn: Jane Carr, (614) 424-7727. Battelle is an independent research and development institute.

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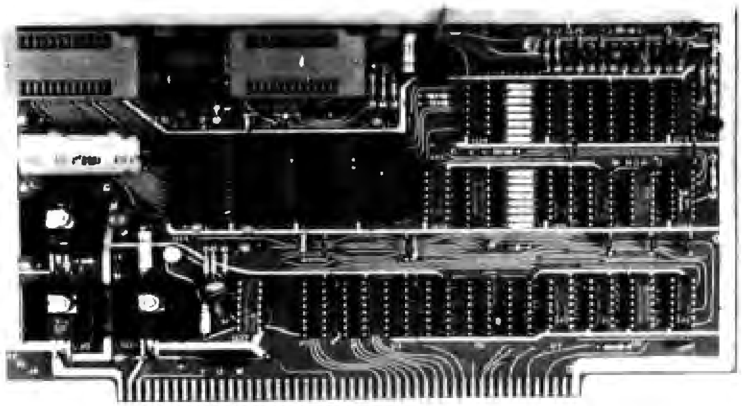

Programming and EPROM Memory on One Board

SSM Microcomputer Products' PB1 S-100 board combines programming and memory capabilities. Four on-card sockets provide a total of 4 K or 8 K bytes of memory, depending upon whether 2708 or 2716 EPROMs (erasable programmable read-only memories) are used. Two programming sockets are provided for a 2708 and a 2716. Separate on-card circuits allow programming of 5 V 2708 and 2716 EPROMs without board modifications. The programming voltage is generated on-board.

The PB1 board with software for programming and verifying EPROMs costs $265. A kit version is available for $179. Contact SSM Microcomputer Products Inc, 2190 Paragon Dr, San Jose CA 95131, (408) 946-7400.

Circle 553 on inquiry card.

MicroCOMPOSER-II

MicroCOMPOSER-II is a typesetting system that is added to a Compuwriter II typesetting machine made by CompuGraphic. MicroCOMPOSER-II consists of software and a hardware interface. The hardware interface is placed inside the Compuwriter and connected to a TRS-80 Model I or III microcomputer. MicroCOMPOSER-II reads files created using the TRS-80's word-processing programs and feeds them to the Compuwriter II for a hardcopy printout.

Cove View Press, the marketing agent for this microApplications Associates' system, recommends using the Scripsit or Electric Pencil word-processing programs. The word-processing programs allow text to be formatted to fit MicroCOMPOSER-II standards. The TRS-80 must have at least 32 K bytes of memory and one or more disk drives. MicroCOMPOSER-II costs $1500. For details, contact Cove View Press, POB 637, Garberville CA 95440, (707) 923-3476.

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Reversible Floppy Disks

Omni Resources has developed a reversible 5-inch floppy disk. Each Omni Flip/Floppy has two recording surfaces, two sets of write-enable notches, two index holes, and reinforcing hub rings. Each disk is rated for over 12 million passes without disk-related errors or significant wear. Omni's 5-pack sells for $21, and a 10-pack costs $40. For more information, contact Omni Resources, 4 Oak Pond Ave, Millbury MA 01527, (800) 343-7620; in Massachusetts (800) 252-8770.

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Double-Density Digital Cassette

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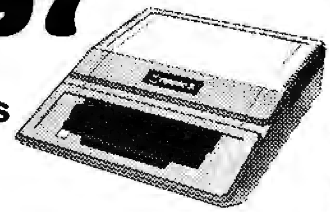

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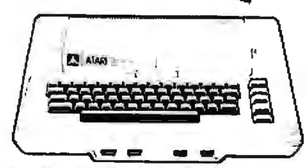

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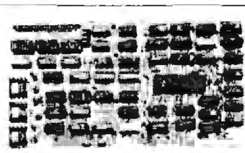

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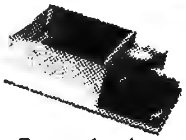

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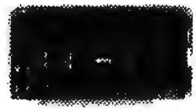

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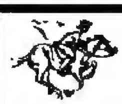

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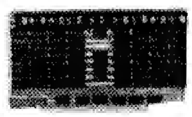

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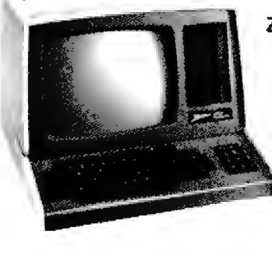

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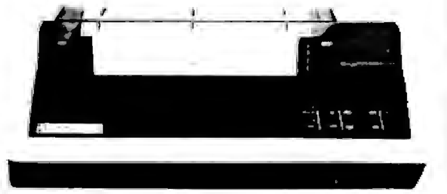

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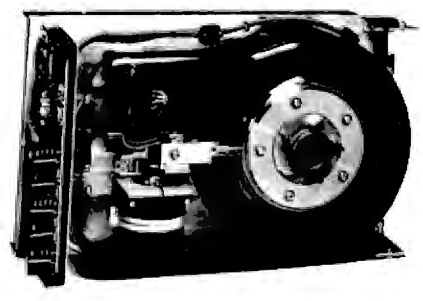

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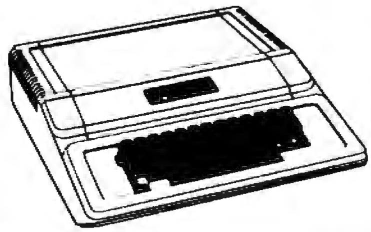

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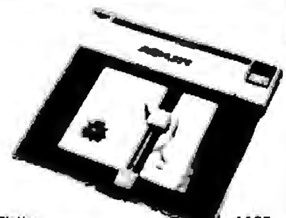

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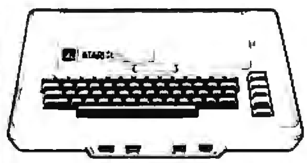

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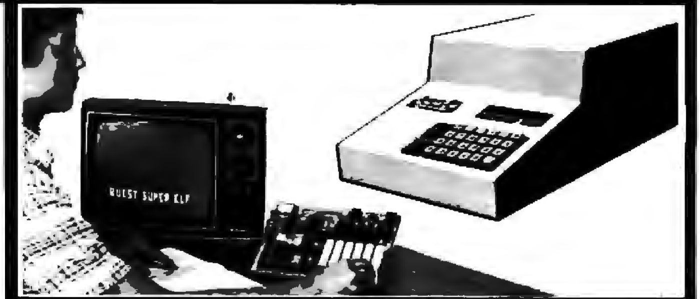

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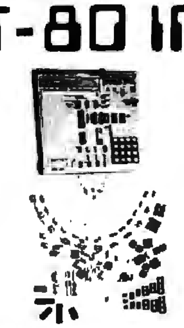

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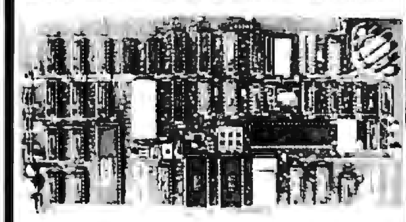

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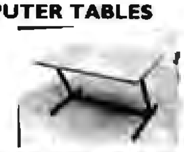

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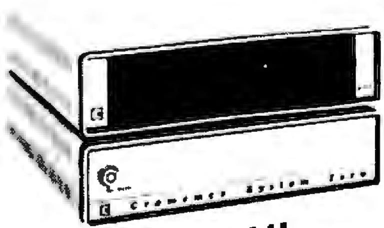

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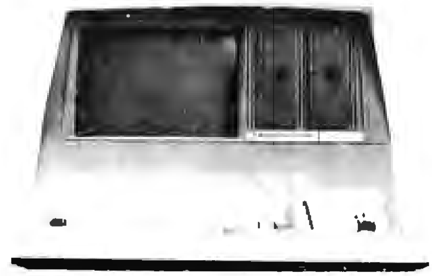

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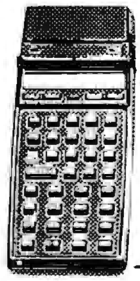

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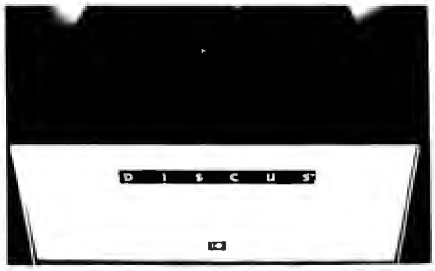

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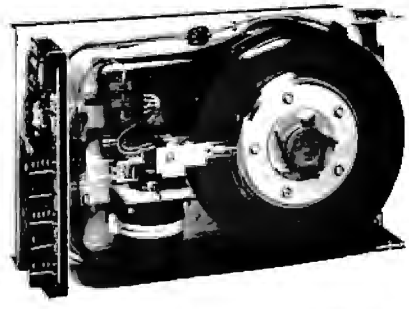

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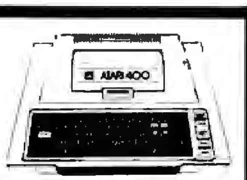

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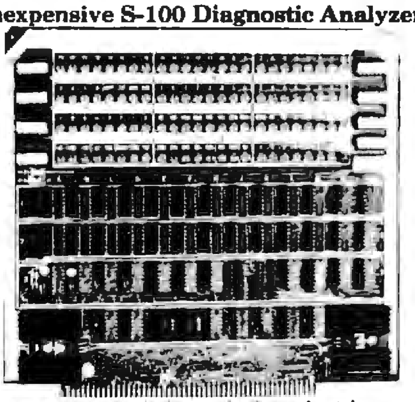


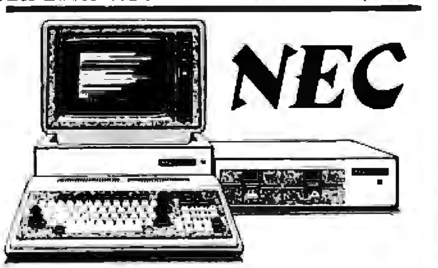
So your computer is down. And you don't have an oscilloscope. And you don't have a front panel... You're not alone - most computers have their occasional bad days. But without diagnostic equipment such as an oscilloscope (expensive!) or a front panel (expensive!), it can be very difficult to pinpoint 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?

Not anymore: Jade is proud to offer our cost-effective solution to the problems mentioned above: THE BUS PROBE.

Whether you're a hobbyist with a cantankerous kluge or a field technician with an anxious computer owner breathing down your neck, you'll find THE BUS PROBE speeds your repair time remarkably. Just plug in THE BUS PROBE and you'll be able to see *all* the IEEE S-100 signals in action. THE BUS PROBE allows you to see inputs, outputs, memory reads and writes, instruction fetches, DMA channels, vectored interrupts, 8 or 16 bit wide data transfers, plus the three bus supply voltages.

An on-board pulse generator can provide repetitive resets, interrupts, or wait states, for trouble shooting.

TSX-200B	*Bare board*	$59.95
TSX-200K	*Kit*	$119.95
TSX-200A	*A&T*	$149.95



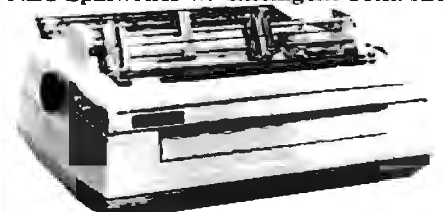
1 MHz Z80 CPU, 80 x 25 display with graphics and 8 colors, 32K RAM, 24K ROM, parallel/serial cassette interfaces, upper lower case, numeric keypad, 10 special function keys, uses CP/M 2.2.

NEC-8001A	*32K CPU/keyboard*	$1095.00
NEC-8012A	*I/O with 32K RAM*	$695.00
NEC-8031A	*Dual disk unit*	$1095.00
VDM-651200	*12" green CRT*	$269.95
NEC-1202D	*Hi-res RGB color CRT*	$1045.00
VDC-651212	*12" color monitor*	$479.95
NEC-9010S	*CP/M 2.2 for NEC*	$150.00
NEC-90005	*Gen. accting softwr*	$375.00

Intersell

Sellum I

NEC Spinwriter w/ Intelligent Controller



Standard serial, Centronics parallel, and current loop interfaces • Selectable baud rates 50 to 19,200 • Automatic bidirectional printing • Logic seeking • 650 character buffer with optional 16K buffer • 55 characters per second print speed • Comes with vertical forms tractor, ribbon, thimble and cable • Diablo compatible software • Available with or without optional front panel

PRD-55511	*1K no front panel*	$2795.00
PRD-55512	*16K no front panel*	$2895.00
PRD-55515	*1K w/front panel*	$2995.00
PRD-55516	*16K w/front panel*	$3095.00

Intersell NEC 3500Q

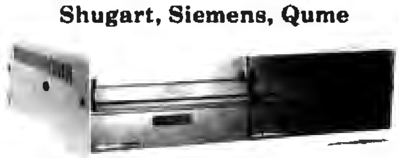
Intersell has announced that, available in September, they will offer a version of the new NEC Model 3500Q Spinwriter (30 cps) that will bring to the customer the same standard features as the Sellum I (except the tractor assembly which is optional on the 3500Q) but incorporating the added features of the NEC Model 3500Q

PRD-55351	*3500Q 1K*	$1995.00
PRD-55352	*3500Q 16K*	$2095.00
PRA-55100	*Deluxe tractor option*	$300.00

JADE

Disk Sub-Systems

Shugart, Siemens, Qume



Handsome metal cabinet with proportionally balanced air flow system • Rugged dual drive power supply • Power cable kit • Power switch, line cord, fuse holder, cooling fan • Never-Mar rubber feet • All necessary hardware to mount 2-8" disk drives, power supply, and fan • Does not include signal cable

Dual 8" Subassembly Cabinet

END-000420	*Bare cabinet*	$59.95
END-000421	*Cabinet kit*	$225.00
END-000431	*A & T*	$359.95

8" Disk Drive Subsystems
Single Sided, Double Density

END-000423	*Kit w 2 FD100-8Ds*	$924.95
END-000424	*A & T w 2 FD100-8Ds*	$1124.95
END-000433	*Kit w 2 SA-801Rs*	$999.95
END-000434	*A & T w 2 SA-801Rs*	$1195.00

8" Disk Drive Subsystems
Double Sided, Double Density

END-000426	*Kit w 2 DT-8s*	$1224.95
END-000427	*A & T w 2 DT-8s*	$1424.95
END-000436	*Kit w 2 SA-851Rs*	$1495.00
END-000437	*A & T w 2 SA-851Rs*	$1695.00

-Special Sale Price-

QUME DT-8

8" Double-Sided, Double-Density Disk Drive

1 Drive ...	$524.95 each
2 Drives	$499.95 each
10 Drives	$479.95 each

Jade Part Number MSF-750080

SIEMENS 8"

8" Single-Sided, Double-Density Disk Drive

1 Drive ...	$384.95 each
2 Drives	$349.95 each
10 Drives	$324.95 each

Jade Part Number MSF-201120

Shugart 801R

8" Single-Sided, Double-Density Disk Drive

1 Drive ...	$394.95 each
2 Drives	$389.95 each

Jade Part Number MSF-10801R

MPI B-51

5¼" Single-Sided, Double-Density Disk Drive

1 Drive ...	$234.95 each
2 Drives	$224.95 each
10 Drives	$219.95 each

Jade Part Number MSM-155100

END-000213	*Case & power supply*	$74.95

Micro-Sci

Apple Disk Drives

Increased Capacity - Decreased Price

40 or 70 track drives • operates with DOS 3.2 and 3.3, Language System, and the Z80 Softcard • 40 and 70 track drives may be mixed on your Apple II • With two 40 track drives you get a 12.5% increase in capacity, 300% improvement in track-to-track access, and save about 15% • With two 70 track drives instead of four 35 track drives you get the same capacity, 300% improvement in track-to-track access time, and save about 45%.

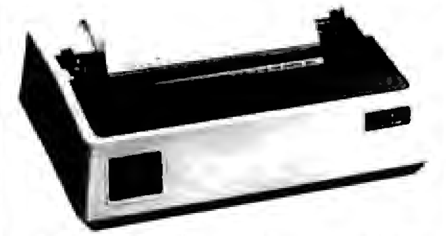
IOD-2340A	*A-40 with cable*	$399.95
IOD-2370A	*A-70 with cable*	$529.95
IOD-2300A	*Micro-sci controller*	$89.95

Circle 210 on inquiry card.

Grand Opening Sale

★★★★★★ *San Diego* ★★★★★★ *Hawthorne* ★★★★★★ *Woodland Hills* ★★★★★★

Printers



BETTER THAN EPSON ! - Okidata

Microline 82A *80/132 column, 120 CPS, 9 x 9 dot matrix, friction feed, pin feed, adjustable tractor feed (removable), handles 4 part forms up to 9.5" wide, rear & bottom feed, paper tear bar, 100% duty cycle/200,000,000 character print head, bi-directional/logic seeking, both serial & parallel interfaces included, front panel switch & program control of 10 different form lengths, uses inexpensive spool type ribbons, double width & condensed characters, true lower case descenders & graphics*

PRM-43082 *with FREE tractor* $544.95

Microline 83A *132/232 column, 120 CPS, handles forms up to 15" wide, plus all the features of the 82A.*

PRM-43083 *with FREE tractor* $774.95

PRA-27081A *Apple card* $39.95
PRA-27082A *Apple cable* $19.95
PRA-27087A *TRS-80 cable* $24.95
PRA-43080 *Extra ribbons pkg. of 2* $9.95

INEXPENSIVE PRINTERS - Epson

MX-70 *80 column, 80 CPS, 5 x 7 dot matrix, adjustable tractor feed, & graphics*

PRM-27070 *List $459* $399.95

MX-80 *80 column, 80 CPS, bi-directional/logic seeking printing, 9 x 9 dot matrix, adjustable tractor feed, & 64 graphics characters*

PRM-27080 *List $645* $474.95

MX-80FT *same as MX-80 with friction feed added.*

PRM-27082 *List $745* $574.95

MX-100 *132 column, correspondence quality, graphics, up to 15" paper, friction feed & adjustable tractor feed, 9 x 9 dot matrix, 80 CPS.*

PRM-27100 *List $945* $795.00

PRA-27084 *Serial interface* $69.95
PRA-27088 *Serial intf & 2K buffer* $144.95
PRA-27081 *Apple card* $74.95
PRA-27082 *Apple cable* $22.95
PRA-27086 *IEEE 488 card* $52.95
PRA-27087 *TRS-80 cable* $32.95
PRA-27085 *Graftrax II* $95.00
PRA-27083 *Extra ribbon* $14.95

Dual-Mode 200 - Malibu

200 CPS 9 x 9 matrix or 70 CPS, 19 x 18 matrix for letter quality, stores up to 12 different fonts, hi-res dot graphics, single sheet and tractor feed, RS-232C and parallel interfaces

PRM-35200 *Dual-Mode 200* $2695.00

16K Atari ... $359.95

ATARI 800 - Atari

Complete personal computer with high resolution color graphics, built in RF modulator, 4 controller ports, internal speaker, 16K RAM & 8K ROM

SYO-2080A *16K Atari 800* $759.95
Atari 800 with 32K of RAM $799.95
Atari 800 with 48K of RAM $849.95
SYO-2040A *16K Atari 400* $359.95
MSM-330810 *Disk drive* $595.00
MSM-330815 *Dual drive* $1395.00
IOX-5050A *850 interface* $199.95
MEX-16853K *16K RAM module* $69.95
SFI-241011005 *Visicalc* $184.95

Accessories for Apple

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.

MEX-16100K *TRS-80 kit* $25.00
MEX-16101K *Apple kit* $25.00
MEX-16102K *Exidy kit* $25.00

16K RAM CARD - for Apple II

Expand your Apple to 64K, 1 year warranty

MEX-16500A *Save $70.00 !!!* $129.95

Z-80* CARD for APPLE

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

8" DISK CONTROLLER

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

IOD-2700A *A & T* $499.95

8" DRIVES for APPLE

Controller, DOS, two 8" double densisty drives, cabinet, power supply, & cables

Special Package Price *Kit* $1399.95

CPS MULTICARD - Mtn. Computer

Three cards in one! Real time clock calendar, serial interface, & parallel interface all on one card.

IOX-2300A *A & T* $199.95

APPLE CLOCK - Cal Comp Sys

Real time clock w/ battery back-up

IOK-2030A *A & T* $109.95

PRINTER INTERFACE - C.C.S.

Centronics type I/O card w/ firmware

IOI-2041A *A & T* $99.95

AIO, ASIO, APIO - S.S.M.

Parallel & serial interface for your Apple (see Byte pg 11)

IOI-2050K *Par & Ser kit* $139.95
IOI-2050A *Par & Ser A & T* $169.95
IOI-2052K *Serial kit* $89.95
IOI-2052A *Serial A & T* $99.95
IOI-2054K *Parallel kit* $69.95
IOI-2054A *Parallel A & T* $89.95

A488 - S.S.M.

IEEE 488 controller, uses simple basic commands, includes firmware and cable, 1 year guarantee, (see April Byte pg 11)

IOX-7488A *A & T* $399.95

Accessories for TRS-80

DISK DRIVES for TRS-80

23% more storage, 8 times faster, 40 track with free patch, 120 day warranty.

MSM-12410C *Save $125.00 !!!* $325.00

8" DISK DRIVES for MODEL II

2 double density drives with cabinet, power supply, & cables

END-000433 *Kit* $1050.00
END-000434 *Assembled* $1250.00
WCA-5036A *Cable (required)* $29.95

EPROM ERASERS

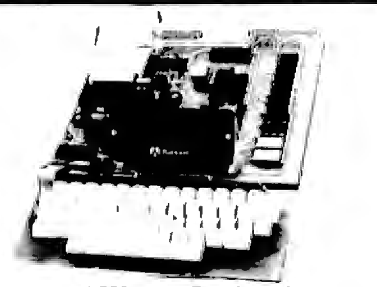
L.S. Engineering UV eraser for up to 48 EPROMs

XME-3200 *A & T* $39.99

Spectronics hi intensity industrial eraser

XME-3100 *Without timer* $69.50

Single Board Computers



AIM-65 - Rockwell

6502 computer with alphanumeric display, printer, & keyboard and complete instructional manuals

CPK-50165 *1K AIM* $424.95
CPK-50465 *1K AIM* $474.95
SFK-74600008E *8K BASIC ROM* $69.95
SFK-64600004E *4K assembler ROM* $39.95
PSX-030A *Power supply* $64.95
ENX-000002 *Enclosure* $54.95

1K AIM, 8K BASIC, power supply, & enclosure

Special package price $659.95

Z-80* STARTER KIT - SD Systems

Complete Z-80 computer with RAM, ROM, I/O, display, keyboard, manual, and kluge area.*

CPS-30010K *Kit* $369.95
CPS-30010A *A & T* $459.95

SYM-1 - Synertek Systems

Single board computer with 1K of RAM, 1K of ROM, keypad, LED display, 20ma & cassette interface on board.

CPK-50020A *A & T* $249.95

Video Terminals

AMBER SCREEN - Volker Craig

Detachable keyboard, amber on black display, 7 x 9 dot matrix, 10 program function keys, 14 key numeric pad, 12" non-glare screen, 50 to 19,200 baud, direct cursor control, auxiliary bi-directional serial port

VDT-351200 *List $795.00* $645.00

VIEWPIONT - ADDS

Detachable keyboard, serial RS232C interface, baud rates from 110 to 19,200, auxiliary serial output port, 24 x 80 display.

VDT-501210 *Sale Priced* $639.95

TELEVIDEO 950

Detachable keyboard, split screen with line lock, etched CRT, programmable function keys, on-screen status line, buffered auxiliary port, 11 x 10 dot matrix, self test, serviced nation-wide by General Electric

VDT-901250 *List $1195.00* $995.00

Video Monitors

HI-RES 12" GREEN - Zenith

15 MHz bandwidth, 700 lines/inch, P31 green phosphor, switchable 40 or 80 columns, small, light-weight & portable.

VDM-201201 *List price $150.00* $118.95

Leedex / Amdek

Reasonably priced video monitors

VDM-801210 *Video 100 12" B&W* $139.95
VDM-801230 *Video 100-80 12" B& W* $179.95
VDM-801250 *12" Green Phospor* $169.95
VDC-801310 *13" Color I* $379.95

12" COLOR MONITOR - NEC

Hi-res monitor with audio & sculptured case

VDC-651212 *Color Monitor* $479.95

12" GREEN SCREEN - NEC

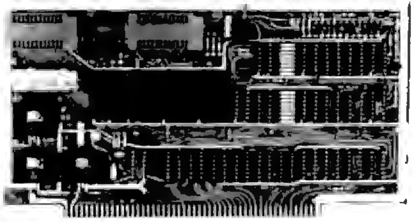
20 MHz, P31 phosphor video monitor with audio, exceptionally high resolution - A fantastic monitor at a very reasonable price

VDM-651200 *12" monitor* $269.95

Grand Opening Sale

★★★★★★ *San Diego* ★★★★★★ *Hawthorne* ★★★★★★ *Woodland Hills* ★★★★★★

S-100 PROM Boards



PB-1 - S.S.M.
2708, 2716 EPROM board with built-in programmer
MEM-99510K *Kit* $154.95
MEM-99510A *A & T* $219.95

PROM-100 - SD Systems
2708, 2716, 2732, 2758, & 2516 EPROM programmer
MEM-99520K *Kit* $219.95
MEM-99520A *Jade A & T* $269.95

EPROM BOARD - Jade
16K or 32K uses 2708's or 2716's, 1K boundary
MEM-16230K *Kit* $79.95
MEM-16230A *A & T* $119.95

S-100 Video

VB-3 - S.S.M.
80 characters x 24 lines expandable to 80 x 48 for a full page of text, upper & lower case, 256 user defined symbols, 160 x 192 graphics matrix, memory mapped, has key board input
IOV-1095K *4 MHz kit* $349.95
IOV-1095A *4 MHz A & T* $439.95
IOV-1096K *80 x 48 upgrade* $39.95

VDB-8024 - SD Systems
*80 x 24 I/O mapped video board with keyboard I/O, and on board Z-80A**
IOV-1020K *Kit* $399.95
IOV-1020A *Jade A & T* $459.95

VIDEO BOARD - S.S.M.
64 characters x 16 lines, 128 x 48 matrix for graphics, full upper/lower case ASCII character set, numbers, symbols, and greek letters, normal/reverse/blinking video, S-100.
IOV-1051K *Kit* $149.95
IOV-1051A *A & T* $219.95
IOV-1051B *Bare board* $34.95

Motherboards

ISO-BUS - Jade
Silent, simple, and on sale - a better motherboard

6 Slot (5¼" x 8½")
MBS-061B *Bare board* $19.95
MBS-061K *Kit* $39.95
MBS-061A *A & T* $49.95

12 Slot (9¾" x 8½")
MBS-121B *Bare board* $29.95
MBS-121K *Kit* $69.95
MBS-121A *A & T* $89.95

18 Slot (14½" x 8½")
MBS-181B *Bare board* $49.95
MBS-181K *Kit* $99.95
MBS-181A *A & T* $139.95

Mainframes

MAINFRAME - Cal Comp Sys
12 slot S-100 mainframe with 20 amp power supply
ENC-112105 *Kit* $329.95
ENC-112106 *A & T* $399.95

DISK MAINFRAME - N.P.C.
Holds 2 8" drives and a 12 slot S-100 system. Attractive metal cabinet with 12 slot motherboard & card cage, power supply, dual fans, lighted switch, and other professional features
ENS-112325 *with 25 amp p.s.* $699.95

S-100 Memory

MEMORY BANK - Jade
4 MHz, S-100, bank selectable, expandable from 16K to 64K
MEM-99730B *Bare board* $49.95
MEM-99730K *Kit, no RAM* $199.95
MEM-16730K *16K kit* $219.95
MEM-32731K *32K kit* $239.95
MEM-48732K *48K kit* $259.95
MEM-64733K *64K kit* $279.95
Assembled & tested .... add $50.00

EXPANDORAM II - S D Systems
4 MHz RAM board expandable from 16K to 64K
MEM-16630K *16K kit* $275.95
MEM-32631K *32K kit* $295.95
MEM-48632K *48K kit* $315.95
MEM-64633K *64K kit* $335.95
Assembled & tested .... add $50.00

64K RAM - Calif Computer Sys
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* $575.00

64K STATIC RAM - Mem. Merch.
64K static S-100 RAM card, 4-16K banks, up to 8 MHz
MEM—64400A *A & T* $825.00

32K STATIC RAM - Jade
2 or 4 MHz expandable static RAM board uses 2114L's
MEM-16151K *16K 4 MHz kit* $169.95
MEM-32151K *32K 4 MHz kit* $299.95
Assembled & tested .... add $50.00

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
MEM-16171A *A & T* $174.95

S-100 Disk Controller

DOUBLE-D - Jade
Double density controller with the inside track, on-board Z-80A, printer port, IEEE S-100, can function on an interrupt driven buss*
IOD-1200K *Kit* $299.95
IOD-1200A *A & T* $375.00
IOD-1200B *Bare board* $59.95

VERSAFLOPPY II - SD Systems
New double density controller for both 8" & 5¼"
IOD-1160K *Kit* $339.95
IOD-1160A *A & T* $379.95

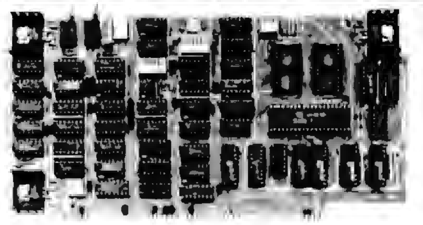
DOUBLE DENSITY - Cal Comp Sys
5¼" and 8" disk controller, single or double density, with on board boot loader ROM, and free CP/M 2.2 and manual set.*
IOD-1300A *A & T* $369.95

S-100 I/O

S.P.I.C. - Jade
Our new I/O card with 2 SIO's, 4 CTC's, and 1 PIO
IOI-1045K *2 CTC's, 1 SIO, 1 PIO* .. $179.95
IOI-1045A *A & T* $239.95
IOI-1046K *4 CTC's, 2 SIO's, 1 PIO* .. $219.95
IOI-1046A *A & T* $299.95
IOI-1045B *Bare board w/ manual* ... $49.95

I/O-4 - S.S.M.
2 serial I/O ports plus 2 parallel I/O ports
IOI-1010K *Kit* $179.95
IOI-1010A *A & T* $249.95
IOI-1010B *Bare board* $35.00

S-100 CPU



CB-2 Z-80 CPU - S.S.M.
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.
CPU-30300K *Kit* $239.95
CPU-30300A *A & T* $299.95

2810 Z-80* CPU - Cal Comp Sys
2/4 MHz Z-80A CPU with RS-232C serial I/O port and on board MOSS 2.2 monitor PROM, front panel compatible.*
CPU-30400A *A & T* $269.95

SBC-200 - SD Systems
4 MHz Z-80 CPU with serial & parallel I/O ports, up to 8K of on-board PROM, software programmable baud rate generator, 1K of on-board RAM, Z-80 CTC.*
CPC-30200K *Kit* $339.95
CPC-30200A *Jade A & T* $399.95

THE BIG Z* - Jade
2 or 4 MHz switchable Z-80 CPU with serial I/O, accomodates 2708, 2716, or 2732 EPROM, baud rates from 75 to 9600*
CPU-30201K *Kit* $139.95
CPU-30201A *A & T* $189.95
CPU-30200B *Bare board* $35.00

Novation Cat Modem

CAT MODEMS - Novation

CAT *300 baud, acoustic, answer/originate*
IOM-5200A *List $189.95* $149.95

D-CAT *300 baud direct connect, answer/originate*
IOM-5201A *List $199.95* $169.95

AUTO-CAT *Auto answer/originate, direct connect*
IOM-5230A *List $299.95* $239.95

Apple-CAT - Novation
Software selectable 1200 or 300 baud, direct connect, auto answer/auto dial, auxiliary 3-wire RS232C serial port for printer.
IOM-5232A *Save $50.00!!!* $325.00

SMARTMODEM - Hayes
Sophisticated direct-connect auto-answer/auto-dial modem, touch-tone or pulse dialing, RS-232C interface, programmable
IOM-5400A *Smartmodem* $269.95

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For Technical Inquires or Customer Service call.
213-973-7707

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Computer Products
4901 W. Rosecrans, Hawthorne, Ca 90250

TERMS of SALE: Cash, checks, credit cards, or Purchase Orders from qualified firms and institutions. Minimum Order $15.00. California residents add 6% tax. Minimum shipping & handling charge $3.00. Pricing & availability subject to change.

Circle 211 on inquiry card.

4K STATIC RAM 8/$20.00

2114 LOW POWER 200 NS

74LS00

74LS00	.25	74LS123	.90	74LS259	2.80
74LS01	.25	74LS124	2.95	74LS260	.60
74LS02	.25	74LS125	.90	74LS261	2.45
74LS03	.25	74LS126	.80	74LS266	.50
74LS04	.25	74LS132	.75	74LS273	1.60
74LS05	.25	74LS136	.50	74LS275	3.30
74LS08	.30	74LS138	.75	74LS279	.50
74LS09	.25	74LS139	.75	74LS280	1.95
74LS10	.25	74LS145	1.10	74LS283	.95
74LS11	.30	74LS147	2.25	74LS290	1.20
74LS12	.30	74LS148	1.25	74LS293	1.80
74LS13	.40	74LS151	.75	74LS295	1.00
74LS14	.75	74LS153	.75	74LS298	.95
74LS15	.30	74LS155	.90	74LS299	2.50
74LS20	.25	74LS156	.90	74LS323	3.95
74LS21	.30	74LS157	.75	74LS324	1.75
74LS22	.25	74LS158	.75	74LS347	1.95
74LS26	.30	74LS160	.90	74LS348	1.95
74LS27	.35	74LS161	.90	74LS352	1.50
74LS28	.35	74LS162	.90	74LS353	1.50
74LS30	.25	74LS163	.90	74LS363	1.35
74LS32	.35	74LS164	.90	74LS365	.90
74LS35	.55	74LS165	.90	74LS366	.90
74LS37	.50	74LS166	2.00	74LS367	.65
74LS38	.35	74LS168	1.70	74LS368	.65
74LS40	.25	74LS169	1.70	74LS373	1.15
74LS42	.50	74LS170	1.70	74LS374	1.75
74LS47	.75	74LS173	.75	74LS375	.65
74LS48	.75	74LS174	.90	74LS377	1.40
74LS49	.75	74LS175	.90	74LS385	1.85
74LS51	.25	74LS181	2.10	74LS386	.60
74LS54	.35	74LS189	9.95	74LS390	1.85
74LS55	.35	74LS190	.95	74LS393	1.85
74LS63	1.20	74LS191	.95	74LS395	1.60
74LS73	.35	74LS192	.80	74LS399	1.65
74LS74	.40	74LS193	.90	74LS424	2.95
74LS75	.50	74LS194	.95	74LS447	.35
74LS76	.40	74LS195	.90	74LS490	1.90
74LS78	.50	74LS196	.80	74LS630	75.00
74LS83	.75	74LS197	.80	74LS640	3.00
74LS85	1.10	74LS221	1.15	74LS641	3.00
74LS86	.40	74LS240	1.15	74LS642	3.00
74LS90	.60	74LS241	1.15	74LS645	3.00
74LS91	.80	74LS242	1.85	74LS668	1.65
74LS92	.65	74LS243	1.85	74LS669	1.85
74LS93	.60	74LS244	1.00	74LS670	2.15
74LS95	.80	74LS245	1.95	74LS674	9.60
74LS96	.80	74LS247	.75	74LS682	3.15
74LS107	.40	74LS248	1.20	74LS683	2.25
74LS109	.40	74LS249	.95	74LS684	2.35
74LS112	.40	74LS251	1.25	74LS685	2.35
74LS113	.40	74LS253	.80	74LS688	2.35
74LS114	.50	74LS257	.80	74LS689	2.35
74LS122	.45	74LS258	.80		

74S00

74S00	.40	74S163	3.70
74S02	.45	74S168	4.60
74S03	.45	74S169	5.40
74S04	.75	74S174	1.05
74S05	.75	74S175	1.05
74S08	.45	74S181	4.45
74S09	.75	74S182	2.90
74S10	.65	74S188	3.90
74S11	.80	74S189	14.90
74S15	.65	74S194	2.90
74S20	.65	74S195	1.85
74S22	.75	74S196	4.85
74S30	.45	74S197	4.20
74S32	.95	74S201	14.90
74S37	1.85	74S225	8.90
74S38	1.85	74S240	3.95
74S40	.40	74S241	3.70
74S51	.75	74S251	1.85
74S64	.75	74S253	7.40
74S65	1.20	74S257	1.35
74S74	.65	74S258	1.45
74S85	2.35	74S260	1.80
74S86	1.40	74S274	19.90
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74S114	1.45	74S287	4.70
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74S134	.65	74S373	3.40
74S135	1.45	74S374	3.40
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74S139	1.20	74S387	5.70
74S140	1.40	74S412	2.95
74S151	1.15	74S471	9.90
74S153	1.15	74S472	16.80
74S157	1.15	74S474	17.80
74S158	1.40	74S482	15.50
74S161	2.80	74S570	7.75
74S162	3.70	74S572	7.75

74C00 CMOS

74C00	.35	74C195	2.20
74C02	.35	74C221	2.20
74C04	.35	74C240	2.20
74C08	.35	74C244	2.20
74C10	.35	74C373	2.70
74C14	1.45	74C374	2.70
74C20	.35	74C901	.80
74C30	.35	74C902	.80
74C32	.50	74C903	.80
74C42	1.70	74C904	.80
74C48	2.05	74C905	10.90
74C73	.65	74C906	.80
74C74	.85	74C907	.90
74C76	1.90	74C908	2.00
74C83	1.90	74C909	2.70
74C85	.90	74C910	9.90
74C89	4.50	74C911	9.90
74C90	1.70	74C912	9.90
74C93	1.70	74C914	1.90
74C95	1.70	74C915	1.90
74C107	.95	74C917	2.70
74C150	5.70	74C918	1.90
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4000	.35	4040	.95	4501	.50
4001	.35	4041	.95	4502	.95
4002	.35	4042	.75	4503	.65
4006	.95	4043	.85	4505	8.95
4007	.35	4044	.85	4506	1.25
4008	.95	4046	.95	4507	.95
4009	.45	4047	.95	4508	1.95
4010	.45	4048	.75	4510	.95
4011	.35	4049	.55	4511	.95
4012	.35	4050	.55	4512	.95
4013	.45	4051	.95	4514	2.25
4014	.95	4052	.95	4515	2.25
4015	.95	4053	.95	4516	1.50
4016	.45	4055	2.75	4518	1.25
4017	.95	4056	2.75	4519	1.25
4018	.95	4059	9.95	4520	1.25
4019	.45	4060	1.25	4522	1.25
4020	.95	4066	.75	4526	1.25
4021	.95	4068	.40	4527	1.75
4022	.95	4069	.40	4528	1.25
4023	.35	4070	.40	4531	.95
4024	.75	4071	.30	4532	1.75
4025	.35	4072	.30	4539	1.75
4026	1.95	4073	.30	4543	1.95
4027	.65	4075	.30	4553	4.95
4028	.80	4076	.95	4555	.95
4029	.95	4078	.50	4556	.95
4030	.45	4081	.40	4558	2.25
4031	1.50	4082	.40	4568	5.95
4032	2.75	4085	.95	4581	1.95
1033	2.75	4086	.95	4582	1.95
4034	2.75	4093	.95	4584	.95
4035	.85	4094	3.95	4585	.95
4037	2.50	4099	1.75	4702	9.95

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		LM308V	.75	LM723	.50
7812CT	.85	LM309K	1.50	LM733	.95
7815CT	.95	LM311V	.60	LM741V	.30
		LM317T	1.90	LM747	.75
7805KT	1.40	LM317K	3.75	LM748V	.60
7812KT	1.40	LM318N	1.50	LM1414	1.50
7815KT	1.40	LM323K	3.75	LM1458V	.65
78L05	.65	LM324N	.60	DS1488N	1.00
78L12	.65	LM337K	3.95	DS1489D	1.00
7905CT	.95	LM339	.75	LM1889	2.45
7912CT	.95	LM377	2.25	LM3900	.60
7915CT	1.15	LM380	1.25	LM3909	.90
		LM386V	1.25	LM3914	3.75
7905K	1.50			LM3915	3.75
7912K	1.50	LM555V	.40	LM3916	3.75
79L05	.75	LM556	.70	DS75451	.40
79L12	.75	LM565	.95	DS75452	.40
79L15	.75	LM566V	1.50	DS75453	.40

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82S147/74S472 (512x8) TS	12.95
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2732 (4K x 8) TS	16.95
2716/2516 5V (2Kx8) TS	7.95
TMS2716 ±5V 12V	17.95
2758 5V 450NS	7.50
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2708 (650NS)	5.25
1702A	5.75
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MM5204Q	9.95

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2513-005 (5V) Lower	10.95
2513-ADM3 (5V) Lower	14.95
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IM6403	8.95
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SALE 2102 .89

21L02 450ns	1.25	[illegible]	[illegible]
21L02 250ns	[illegible]	[illegible]	[illegible]
2111	[illegible]	[illegible]	[illegible]
2112	[illegible]	[illegible]	[illegible]
2101	[illegible]	[illegible]	[illegible]
2114N (450NS)	3.75	3.50	3.25
2114L 250ns (4045)	[illegible]	[illegible]	[illegible]
2114L 450ns (4045)	4.25	4.25	3.95
4044 250 ns	[illegible]	[illegible]	[illegible]
4044 450ns	[illegible]	[illegible]	[illegible]
TMS4044	[illegible]	[illegible]	[illegible]
TMS4045	[illegible]	[illegible]	[illegible]
AM91L02	[illegible]	[illegible]	[illegible]
AM9130	[illegible]	[illegible]	[illegible]
5101	[illegible]	[illegible]	[illegible]
P2125 N1445 (45ns)	[illegible]	[illegible]	[illegible]
6518 1K x 1 CMOS	7.95	7.36	7.25
2147 Low Power 4K Stat	[illegible]	[illegible]	[illegible]
93415	9.95	8.95	8.50

DYNAMIC RAMS

4164/4116 16K (16 Pin)	2.49
Set of 8 416's 200 Ns	24.95
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4050 4K (18 Pin)	[illegible]
4060 4K (22 Pin)	[illegible]
4096 4K (16 Pin)	[illegible]
2104 4K (16 Pin)	[illegible]
4027 4K (16 Pin) UPD 414	4.95

64K RAMS $19.95

SOCKETS

# Pins	Lo-Pro Soldertail	Wire Wrap 3 Level Tin	Wire Wrap 3 Level Gold
[illegible]	[illegible]	[illegible]	[illegible]

ZERO INSERTION FORCE

16 Pin [illegible] 24 Pin [illegible] 40 Pin [illegible]

LED READOUTS

[illegible]

IC SPECIAL PURCHASE

82S09 64x9 Ram			8.95
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TYPE	DESCRIPTION	PRICE PER 10
[illegible]	[illegible]	[illegible]

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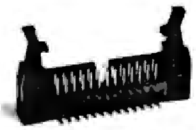
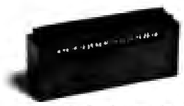
IDC CONNECTORS



RIGHT ANGLE HEADERS

	SOLDER TAIL		WIRE WRAP	
Size	Part No.	Price	Part No.	Price
10	IDH10SRB	$1.20	IDH10WRB	$2.60
20	IDH20SRB	1.90	IDH20WRB	4.15
26	IDH26SRB	2.75	IDH26WRB	5.35
34	IDH34SRB	3.75	IDH34WRB	6.25
40	IDH40SRB	3.75	IDH40WRB	7.35
50	IDH50SRB	4.75	IDH50WRB	9.20

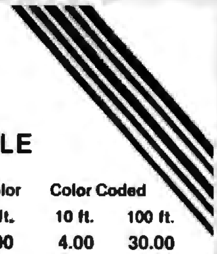
.1" Spacing. Mounts on PC Board & Mates with IDS Socket below. Ejector Bars - 4/1.00.



EDGE CARD CONNECTORS

Size	Part No.	Price
10	IDE10B	$3.95
20	IDE20B	4.35
26	IDE26B	5.00
34	IDE34B	6.05
40	IDE40B	6.90
50	IDE50B	7.50

.1" Spacing. Crimps onto cable with ordinary vise & mates with standard .062" Card Edge.



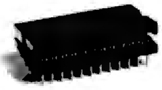
RIBBON CABLE

	Solid Color		Color Coded	
Size	10 ft.	100 ft.	10 ft.	100 ft.
10	2.90	17.00	4.00	30.00
14	3.40	23.80	5.00	42.00
16	3.70	27.20	5.60	48.00
20	4.40	34.00	7.00	60.00
24	5.00	40.80	8.00	72.00
26	5.40	44.20	8.60	78.00
34	6.80	57.80	11.00	102.00
40	7.80	68.00	13.00	120.00
50	9.50	85.00	16.00	150.00

25 PIN "D" CONNECTORS

Solder Style	Part No.	Price
Male	DB25P	$2.95
Female	DB25S	3.95
Cover	DB25C	1.50
IDC Style		
Male	IDB25P	6.25
Female	IDB25S	6.60
Cover	IDB25C	1.60

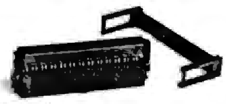
Solder Style solders onto cable, IDC Style crimps onto cable with vise. 9, 15, 37 and 50 pin available also.



CABLE PLUGS

Size	Part No.	Price
14	IDP14B	$1.45
16	IDP16B	1.65
24	IDP24B	2.50
40	IDP40B	4.15

.1" Spacing. Crimps onto cable with ordinary vise & plugs into standard IC Socket.



SOCKETS

Size	Part No.	Price
10	IDS10B	$1.88
20	IDS20B	2.75
26	IDS26B	3.50
34	IDS34B	4.50
40	IDS40B	5.40
50	IDS50B	6.50

.1" Spacing. Crimps onto cable with ordinary vise & mounts to header sold above.

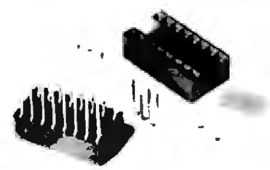
WIRE WRAP SUPPLIES

WIRE WRAP WIRE

#30 Wire Wrap Wire

Length	100/Bag	500/Bag	1K/Bag
2.5"	$1.38	$3.94	$6.81
3.0"	1.43	4.25	7.46
3.5"	1.51	4.57	8.11
4.0"	1.56	4.88	8.73
4.5"	1.63	5.21	9.39
5.0"	1.69	5.54	10.04
5.5"	1.74	5.92	10.69
6.0"	1.82	6.23	11.34
6.5"	2.11	7.08	12.99
7.0"	2.19	7.44	13.68
7.5"	2.29	7.78	14.40
8.0"	2.35	8.12	15.10
8.5"	2.40	8.46	15.80
9.0"	2.46	8.92	16.51
9.5"	2.53	9.15	17.22
10.0"	2.63	9.58	17.91

All lengths are overall, including 1" strip on each end. Choose from colors; Red, Blue, Black, Yellow, White, Green, Orange, and Violet.



Size	Part No.	Each	Tube
08	ICN083WBSG	.44	52x .39 = $20.28
14	ICN143WBSG	.53	30x .46 = $13.80
16	ICN163WBSG	.58	26x .50 = $13.00
18	ICN183WBSG	.78	23x .68 = $15.64
20	ICN203WBSG	1.00	21x .85 = $17.85
22	ICN224WBSG	1.07	19x .92 = $17.48
24	ICN246WBSG	1.09	17x1.09 = $15.98
28	ICN286WBSG	1.43	15x1.23 = $18.45
40	ICN406WBSG	1.85	10x1.60 = $16.00

Selective Plating provides gold in contact where it counts. 3-level wrap. Save by buying sockets by the tube. All gold available at ½¢/pin extra charge.

* * * No Discount

WIRE KITS

Kit No. 1 — $9.95

250	3"	100	4½"
200	3½"	100	5"
100	4"	100	6"

Kit No. 2 — $24.95

250	2½"	250	5"
500	3"	100	5½"
500	3½"	100	6"
500	4"	100	6½"
250	4½"	100	7"

Kit No. 3 — $34.95

250	2½"	500	4½"
500	3"	500	5"
500	3½"	500	5½"
500	4"	500	6"

Kit No. 4 — $59.95

500	2½"	1000	4½"
1000	3"	1000	5"
1000	3½"	1000	5½"
1000	4"	1000	6"

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Prepaid orders over $50 shipped prepaid via UPS. All others add $3.00 for handling. VISA, MC, COD's and open account orders will be charged freight. $15 minimum order. $100 minimum open account order.

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74LS11	35	74LS181	2.15
74LS12	35	74LS189	8.95
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74LS15	35	74LS192	.85
74LS20	25	74LS193	.95
74LS21	35	74LS194	1.00
74LS22	25	74LS195	.95
74LS26	35	74LS196	.85
74LS27	35	74LS197	.85
74LS28	35	74LS221	1.20
74LS30	25	74LS240	.99
74LS32	35	74LS241	.99
74LS33	.55	74LS242	1.85
74LS37	55	74LS243	1.85
74LS38	35	74LS244	.99
74LS40	.25	74LS245	1.90
74LS42	55	74LS247	.75
74LS47	75	74LS248	1.25
74LS48	75	74LS249	.99
74LS49	75	74LS251	1.30
74LS51	25	74LS253	.85
74LS54	35	74LS257	.85
74LS55	35	74LS258	.85
74LS63	1 25	74LS259	2.85
74LS73	40	74LS260	.65
74LS74	45	74LS266	.55
74LS75	60	74LS273	1.65
74LS76	40	74LS275	3.35
74LS78	50	74LS279	.55
74LS83	75	74LS280	1.98
74LS85	1 15	74LS283	1.00
74LS86	40	74LS290	1.25
74LS90	65	74LS293	1.85
74LS91	89	74LS295	1.05
74LS92	70	74LS298	1.20
74LS93	65	74LS324	1.75
74LS95	85	74LS352	1.55
74LS96	95	74LS353	1.55
74LS107	40	74LS363	1.35
74LS109	40	74LS364	1.95
74LS112	45	74LS365	.95
74LS113	45	74LS366	.95
74LS114	50	74LS367	.70
74LS122	45	74LS368	.70
74LS123	.95	74LS373	.99
74LS124	2.99	74LS374	1.75
74LS125	.95	74LS377	1.45
74LS126	85	74LS378	1.18
74LS132	75	74LS379	1.35
74LS136	.55	74LS385	1.90
74LS137	99	74LS386	.65
74LS138	75	74LS390	1.90
74LS139	.75	74LS393	1.90
74LS145	1.20	74LS395	1.85
74LS147	2.49	74LS399	1.70
74LS148	1.35	74LS447	.37
74LS151	75	74LS490	1.95
74LS153	75	74LS668	1.69
74LS154	2.35	74LS669	1.89
74LS155	1 15	74LS670	2.20
74LS156	95	74LS674	9.65
74LS157	75	74LS682	3.20
74LS158	75	74LS683	2.30
74LS160	90	74LS684	2.40
74LS161	95	74LS685	2.40
74LS162	95	74LS688	2.40
74LS163	85	74LS689	2.40

8200

8202	45.00
8205	3.50
8212	1.85
8214	3.85
8216	1.80
8224	2.50
8226	1.80
8228	4.90
8237	19.95
8238	4.85
8243	4.45
8250	14.95
8251	5.40
8253	9.85
8253-5	8.85
8255	5.15
8255-5	5.25
8257	8.75
8259	6.90
8272	39.95
8275	29.95
8279	10.50
8279-5	10.50
8282	6.65
8283	6.65
8284	5.70
8286	6.65
8287	6.50
8288	25.00
8289	49.95

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8155	11 95
8156	11 95
8185	29.95
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8741	39 95
8748	69 95
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Z80-SIO/9	17.95
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MISC.

8T26	1 69	3242	7.95
8T28	2 49	AY5-1013	3.95
8T95	99	TR1602	4.95
8T96	.89	IM6402	7.95
8T97	99	1771	24.95
8T98	.99	1791	36 95
1488	99	1793	49.95
1489	99	UPD765	39.95
DM8131	2.98	8272	39.95
14411	9 95	74C923	5 95

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PN2222	10/1.00	100/8.99
2N3904	10/1 00	100/8.99
2N3906	10/1.00	100/8.89
2N3055	79	10/6 99
IN4148		25/1.00
IN4004		10/1 00

6800

6800	5.70
6802	11.95
6809	37.95
6810	4.80
6820	4.95
6821	3.45
6828	9.95
6834	18.95
6840	14.95
6843	42.95
6844	44.95
6845	29.95
6847	15.95
6850	3.50
6852	5.75
6860	10.95
6862	11.95
6871	25.95
6875	6.95
6880	1.75

T.V. CIRCUITS

MC1330	1.89
MC1350	1 29
MC1358	1.79
LM380	1 29
LM386	1.50
LM565	.99
LM741	29
LM1310	2.90
LM1800	2.99
LM1889	2.49

6502

6502	6.95
6502A	12.95
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6520	4.35
6522	9.95
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EPROMS

1702	256 x 8	(1us)	4.95	4.50
2708	1024 x 8	(450ns)	3.95	3.50
2758	1024 x 8	(450ns)(5v)	9.95	8.95
TMS2516	2048 x 8	(450ns)(5v)	7.95	6.95
2716	2048 x 8	(450ns)(5v)	5.50	5.00
2716-1	2048 x 8	(350ns)(5v)	12.95	11 95
TMS2716	2048 x 8	(450ns)	9.95	8.95
TMS2532	4096 x 8	(450ns)(5v)	19.95	17.95
2732	4096 x 8	(450ns)(5v)	16.50	15.95

STATIC RAMS

				100pcs
2101	256 x 4	(450ns)	1.95	1.85
2102-1	1024 x 1	(450ns)	89	.85
21L02-1	1024 x 1	(450ns)(LP)	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)	8/17.95	2.10
2114L-2	1024 x 4	(200ns)(LP)	8/22.95	2.45
2114L-3	1024 x 4	(300ns)(LP)	8/18.95	2.25
2114L-4	1024 x 4	(450ns)(LP)	8/18 95	2 25
TMS4044-4	4096 x 1	(450ns)	3 49	3 25
TMS4044-3	4096 x 1	(300ns)	3.99	3.75
TMM2016	2048 x 8	(200ns)	CALL	
HM6116	2048 x 8	(200ns)	CALL	

DYNAMIC RAMS

				100pcs
4027	4096 x 1	(250ns)	2.50	2 00
4116-150	16,384 x 1	(150ns)	8/18.95	1.95
4116-200	16,384 x 1	(200ns)	8/15.95	1.80
4116-300	16,384 x 1	(300ns)	8/14.95	1.75
4164	65,536 x 1	(200ns)	CALL	

LP=LOW POWER

DIP SWITCHES

4 position	.85
5 position	90
6 position	90
7 position	.95
8 position	.95

CONNECTORS

RS232 MALE	3.25
RS232 FEMALE	3.75
RS232 HOOD	1.25
S-100 ST	3.95
S-100 WW	4.95

LEDS

Jumbo Red	10/1 00
Jumbo Green	6/1.00
Jumbo Yellow	6/1.00
5082-7760 .43'CC	.79
MAN74 3'CC	.99
MAN72 .3'CA	99

LINEAR

LM301V	34	LM741V	.29
LM308V	98	LM747	79
LM309K	1 49	LM748V	.59
LM311	64	LM1310	2.90
LM317T	1 95	MC1330V	1.89
LM317K	3.95	MC1350V	1.29
LM318	1 49	MC1358	1.79
LM323K	4.95	LM1414	1.59
LM324	.69	LM1458V	69
LM337K	3 95	LM1488	.99
LM339	99	LM1489	.99
LM377	2 29	LM1800	2.99
LM380	1 29	LM1889	2.48
LM386V	1 60	LM3900	59
LM555V	39	LM3909V	98
LM556	69	LM3914	3 95
LM565	99	LM3915	3 95
LM566V	1 49	LM3916	3.95
LM567V	1 29	75451V	39
LM723	49	75452V	39
LM733	98	75453V	39

T=TO-220 V=8 PIN K=TO-3

VOLTAGE REG'S

7805T	.89	7905T	.99
7808T	.99	7912T	.99
7812T	.89	7915T	1 19
7815T	.89	7924T	1 19
7824T	.99		
7805K	1.39	7905K	1.49
7812K	1.39	7912K	1 49
7815K	1.39	79L05	.79
78L05	.69	79L12	79
78L12	.69	79L15	79
78L15	.69	LM317K	3.95
LM309K	1.49	LM323K	4.95
LM317T	1.95	LM337K	3.95

T=TO-220 K=TO-3 L=TO-92

IC SOCKETS

	1-100	100pcs
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		
8 pin WW	.59	.49
14 pin WW	69	52
16 pin WW	69	58
18 pin WW	.99	.90
20 pin WW	1 09	.98
22 pin WW	1.39	1 28
24 pin WW	1 49	1.35
28 pin WW	1.69	1 49
40 pin WW	1 99	1.80

WW = WIREWRAP

master charge VISA

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Circle 213 on inquiry card.

2716 EPROMS 450NS (5V) 8/5.00 ea.

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CMOS

74C00	.35	74C374	2.75	4019	.45	4098	2.49
74C02	.35	74C901	.80	4020	.95	4099	1.95
74C04	.35	74C902	.85	4021	95	14409	8.95
74C08	.35	74C903	.85	4022	1.15	14410	8.95
74C10	35	74C905	10.95	4023	.35	14411	9.95
74C14	1.50	74C906	95	4024	.75	14412	12.95
74C20	35	74C907	1.00	4025	.35	14419	2.95
74C30	.35	74C908	2.00	4026	1 65	4502	95
74C32	.50	74C909	2.75	4027	65	4503	.65
74C42	1.75	74C910	9.95	4028	.80	4508	1 95
74C48	2.10	74C911	10.00	4029	.95	4510	.95
74C73	.65	74C912	10.00	4030	.45	4511	95
74C74	.85	74C914	1.95	4034	2.95	4512	.95
74C76	.80	74C915	2.00	4035	.85	4514	1.25
74C83	1.95	74C918	2.75	4040	95	4515	2.25
74C85	1.95	74C920	17.95	4041	1.25	4516	1.55
74C86	.95	74C921	15.95	4042	75	4518	1.25
74C89	4 50	74C922	5.95	4043	85	4519	1.25
74C90	1.75	74C923	5.95	4044	85	4520	1.25
74C93	1.75	74C925	6.75	4046	95	4522	1 25
74C95	1.75	74C926	7.95	4047	95	4526	1.25
74C107	1.00	74C927	7.95	4049	55	4527	1 95
74C150	5.75	74C928	7.95	4050	.55	4528	1.25
74C151	2.25	74C929	19.95	4051	95	4531	95
74C154	3.25	74C930	19.95	4053	95	4532	1.95
74C157	1.75	4000	.35	4060	1.45	4538	1.95
74C160	2.00	4001	.35	4066	.75	4539	1.95
74C161	2 00	4002	25	4068	40	4543	2 70
74C162	2 00	4006	.95	4069	35	4555	95
74C163	2.00	4007	.29	4070	35	4556	.95
74C164	2.00	4008	95	4071	.30	4581	1 95
74C165	2.00	4009	.45	4072	30	4582	1 95
74C173	2.00	4010	45	4073	.30	4584	95
74C174	2 25	4011	35	4075	.30	4585	.95
74C175	2.25	4012	25	4076	.95	4702	12.95
74C192	2 25	4013	.45	4078	.30	4724	1.50
74C193	2.25	4014	95	4081	.30	80C07	.95
74C195	2.25	4015	.95	4082	.30	80C95	.85
74C200	5.75	4016	.45	4085	.95	80C96	.95
74C221	2.25	4017	1.15	4086	.95	80C97	.95
74C373	2.75	4018	.95	4093	.95	80C98	1 20

7400 SERIES

7400	19	74128	.55
7401	19	74132	.45
7402	19	74136	.50
7403	.19	74141	.65
7404	.19	74142	2.95
7405	.22	74143	2.95
7406	.22	74144	2.95
7407	.22	74145	.60
7408	.24	74147	1 75
7409	19	74148	1.20
7410	.19	74150	1,35
7411	.25	74151	65
7412	30	74152	.65
7413	.35	74153	.55
7414	.55	74154	1.40
7416	.25	74155	.75
7417	.25	74156	.65
7420	.19	74157	.55
7421	.35	74159	1.65
7422	.29	74160	.85
7423	.29	74161	70
7425	.29	74162	.85
7426	.29	74163	.85
7427	.29	74164	.85
7428	45	74165	.85
7430	.19	74166	1.00
7432	.29	74167	1.95
7433	.45	74170	1.65
7437	.29	74172	5.95
7438	.28	74173	.75
7440	19	74174	.89
7442	.49	74175	.89
7443	.65	74176	.89
7444	.69	74177	.75
7445	.69	74178	1.15
7446	.59	74179	1.75
7447	.69	74180	75
7448	.69	74181	2.25
7450	.19	74182	.75
7451	.23	74184	2.00
7453	.23	74185	2.00
7454	.23	74186	18.50
7460	.23	74190	1.15
7464	.39	74191	1.15
7465	.39	74192	.79
7470	.35	74193	.79
7472	.29	74194	.85
7473	.34	74195	.85
7474	.35	74196	.79
7475	.49	74197	.75
7476	.35	74198	1.35
7480	.59	74199	1.35
7481	1.10	74221	1.35
7482	.95	74246	1.35
7483	.50	74247	1.25
7484	.50	74248	1.85
7485	.65	74249	1.95
7486	.35	74251	.75
7489	4.95	74259	2.25
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
74100	1.00	74293	.75
74107	.30	74298	.85
74109	45	74351	2.25
74110	45	74365	65
74111	.55	74366	.65
74116	1.55	74367	.65
74120	1.20	74368	.65
74121	.29	74376	2.20
74122	.45	74390	1.75
74123	.55	74393	1.35
74125	.45	74425	3.15
74126	.45	74426	85
		74490	2.55

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4116	150NS	16K x 1	**8/18.95**
4116	120NS	16K x 1	8/29.95

STATIC RAMS

2147	55NS	4K x 1	9.95
6116	150NS	2K x 8	CALL
6116	120NS	2K x 8	CALL

EPROMS

2716-1	350NS	2K x 8	12.95
2732A	250NS	4K x 8	25.95
2732A-2	200NS	4K x 8	32.95

MPU's

Z-80B	CPU	6mHz	**18.95**
Z-80B	CTC	6mHz	17.95
Z-80B	PIO	6mHz	17.95
68B00	CPU	2mHz	10.95
68B21	PIA	2mHz	12.95
68B50	ACIA	2mHz	12.95
8085A-2	CPU	5mHz	16.95

74S00 SERIES

74S00	.44	74S74	.69	74S163	3.75	74S258	1.49
74S02	.48	74S85	2.39	74S168	4.65	74S260	1.83
74S03	.48	74S86	1.44	74S169	5.44	74S274	19.95
74S04	.79	74S112	1.59	74S174	1.09	74S275	19.95
74S05	.79	74S113	1.98	74S175	1.09	74S280	2.90
74S08	.48	74S114	1.50	74S181	4.47	74S287	4.75
74S09	98	74S124	2.77	74S182	2.95	74S288	4.45
74S10	.69	74S132	1.24	74S188	3.95	74S289	6.98
74S11	88	74S133	.98	74S189	14.95	74S301	6.95
74S15	.70	74S134	.69	74S194	2.95	74S373	3.45
74S20	.68	74S135	1.48	74S195	1.89	74S374	3.45
74S22	98	74S138	1.08	74S196	4.90	74S381	7.95
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74S37	1.67	74S151	1 19	74S225	8.95	74S471	9.95
74S38	1 68	74S153	1.19	74S240	3.98	74S472	16.85
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74S51	78	74S158	1 45	74S251	1.90	74S482	15.60
74S64	79	74S161	2.85	74S253	7.45	74S570	7 80
74S65	1.25	74S162	3 70	74S257	1.39	74S571	7 80

PROMS

74S188	(82S23)	OC	32 x 8	3.95
74S287	(82S129)	TS	256 x 4	4.75
74S288	(82S123)	TS	32 x 8	4.45
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74S471		TS	256 x 8	9.95
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74S570	(82S130)	OC	512 x 4	7.80
74S571	(82S131)	TS	512 x 4	7.80

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SUPER RAM • II

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- SAVE REPAIR CHARGES
- INCREASES RELIABILITY
- CLIPS ON—NO HOLES OR SCREWS
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HOW TO HOOK IT UP

1. Clip it on your APPLE
2. Unplug your 120V cable (you won't need it)
3. Plug short 120V cable from Super Fan II to the back of your computer
4. Plug the supply cable from Super Fan II to your 120V power source
5. Turn on the rocker switch and a built-in red ready light comes on
6. You are all set "COOL IT"

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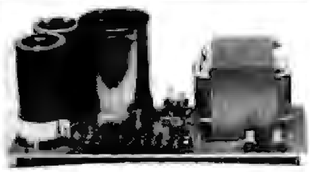
SUNNY LOW LOW COST

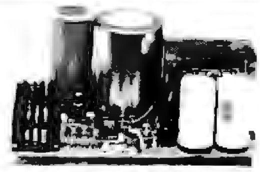
POWER SUPPLIES

FOR S-100, FLOPPY DISKS.



KIT 1, 2 & 3 For S-100

R3 For Three 8" or 5¼" Disk Drives



S3 2 in 1 Unit for S-100 and two 8" or 5¼" Disk Drives. It fits most Disk System Mainframes.

S-100 POWER SUPPLY KITS (OPEN FRAME WITH BASE PLATE, 3 HRS. ASSY. TIME)

ITEM	USED FOR	@ + 8 Vdc	@ - 9 Vdc	@ + 16 Vdc	@ - 16 Vdc	@ - 28 Vdc	SIZE W × D • H	PRICE
KIT 1	15 CARDS SOURCE	15A	————	2.5A	2.5A	——	12" × 5" × 4⅞"	52.95
KIT 2	SYSTEM SOURCE	25A	————	3A	3A	————	12" × 5" × 4⅞"	59.95
KIT 3	DISK SYSTEM	15A	1A	2A	2A	4A	14" × 6" × 4⅞"	67.95

DISK DRIVE POWER SUPPLY "R3" REGULATED, OPEN FRAME, ASSY. & TESTED 67.95

SPECS + 5V @ 5A OVP 5V @ 1A + 24V@ 5A. SHORTS PROTECT 2 SIZES AVAIL. 1) 9" (W) × 6¼" (D) × 4⅜" (H). 2) 9" (W) × 4⅞ (D) × 5¼" (H)
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IDEAL FOR THREE 8 or 5¼ FLOPPY DISK DRIVES, SUCH AS SHUGART 801/851 SIEMANS FDD 100-8/200-8 OR 100-5 ETC

DISK SYSTEM PWR SUPPLY "S3" OPEN FRAME, ASSY. & TESTED. COMPACT SIZE: 10 (W) • 6' (D) × 5 (H) 92.95

REGULATED OUTPUTS FOR DISK DRIVES +5V @ 4A. 5V @ 1A. +24V @ 4A (OR + 12V @ 4A) SHORTS PROTECT
UNREGULATED OUTPUTS FOR S 100 +8V @ 14A ± 16V @ 3A (OPTION ADD OVP FOR +5V. ADD $5.00)
A COMPLETE UNIT FOR DISK SYSTEM WITH THE MAINFRAME CONTAINING 12 SLOTS & TWO 8" or 5¼" DISK DRIVES

POWER TRANSFORMERS (WITH MOUNTING BRACKETS)

ITEM	PRIMARY	SECONDARY #1	SECONDARY #2	SECONDARY #3	SIZE W × D × H	PRICE
T_1	110/120	2 × 8 Vac, 15A	28 Vac, CT, 2.5A		3¾" × 3⅝" × 3⅛"	21.95
T_2	110/120	2 × 8 Vac, 25A	28 Vac, CT, 3.5A		3¾" × 4⅜" × 3⅛"	27.95
T_3	110/120	2 × 8 Vac, 15A	28 Vac, CT, 2.5A	48 Vac, CT, 2A	3¾" × 4⅜" × 3⅛"	29.95
T_4	110/120	2 × 8 Vac, 6A	28 Vac, CT, 1.5A	48 Vac, CT, 3A	3¾" × 3⅝" × 3⅛"	22.95
T_5	110/120	2 × 8 Vac, 6A	28 Vac, CT, 2A		3" × 3" × 2½"	14.95

SHIPPING For each power supply $5.50 in Calif., $7.50 in other states, $14.00 in Canada. For each Transformer $5.00 in all States, $10.00 in Canada. Calif. Residents add 6% Sales Tax.

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COMM-80™

Featured in May/June '80 BYTE

- RS-232-C port (50-19.2K baud) software/hardware selectable
- Centronics printer port 8-bit
- connects to keyboard or E.I.
- chain up to 16 units
- use with E.I. for 2nd printer
- includes terminal software
- only $179.95 complete

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DISK-80™

Featured in March '81 BYTE

- disk controller (4 drives)
- hardware data separator
- includes 16K of RAM provision for additional 16K
- buffered TRS-bus connector
- real-time clock
- printer port (optional)

ASSEMBLED & TESTED
with 16K of RAM $329.95
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with 32K RAM add... $ 50.00
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- received data automatically routed to printer ports
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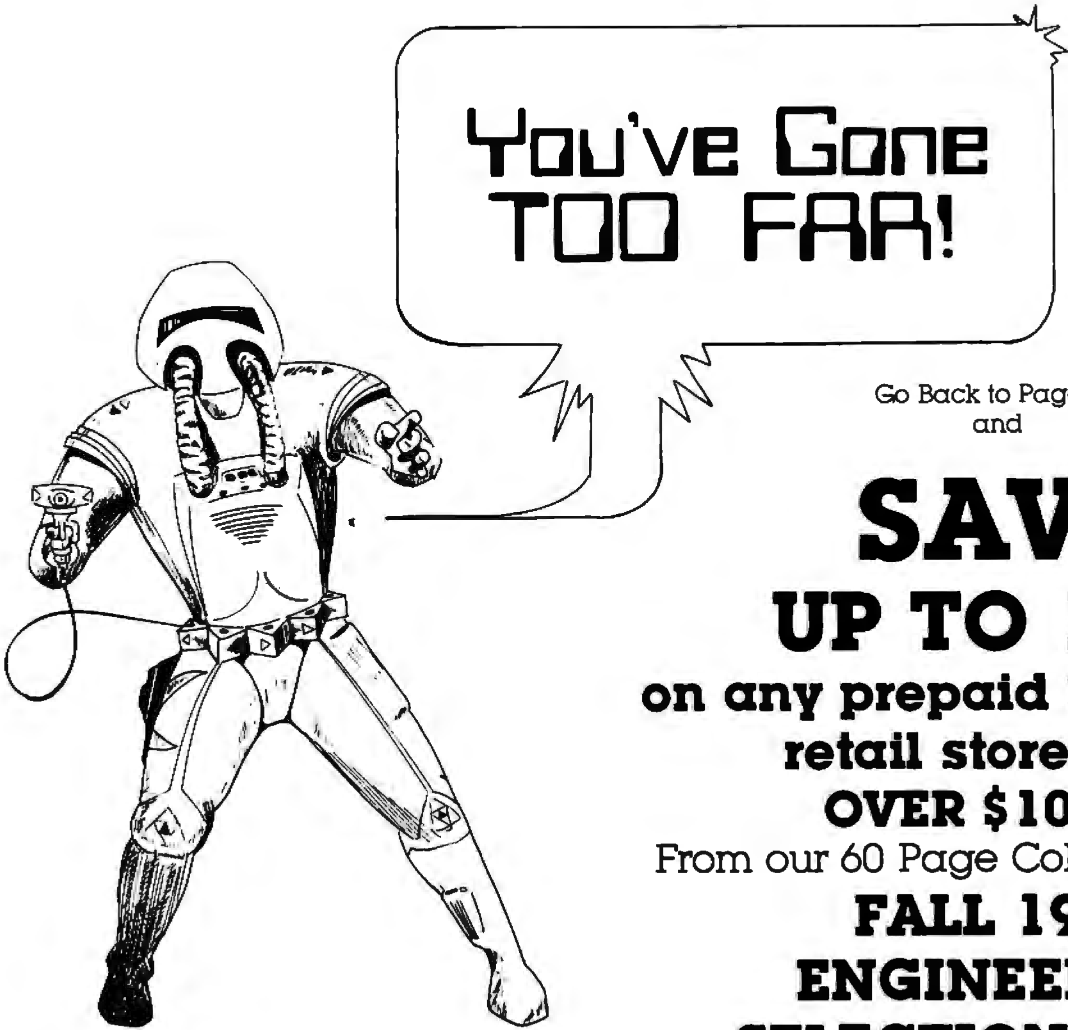

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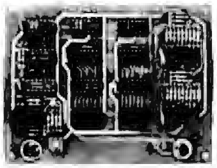
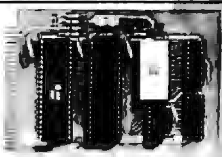
A-D & D-A CONVERTER



JBE one channel A-D & D-A Converter can be used with any system having parallel ports • Interfaces with JBE Parallel I/O Card • D-A conversion time — 5 μs • A-D conversion time — 20 μs • Uses JBE 5V power supply • Parallel inputs & outputs include 8 data bits, strobe lines & latches • Analog inputs & outputs are medium impedance 0 to 5 volt range.

79-287 ASSM. $79.95
Bare Board $39.95 Kit $59.95

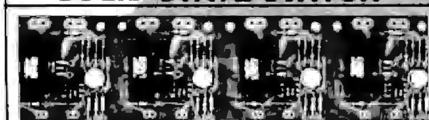
6502 MICROCOMPUTER



JBE's 4½x3¼ dedicated controller features: • 1024 bytes RAM (two 2114s) • 2048 bytes EPROM (2716) • Uses one 6522 VIA (comp. doc. incl.) • Interfaces with JBE Solid State Switches & A-D & D-A Converter • Uses JBE 5V power supply • 2716 EPROM available separately (2716 can be programmed with an Apple II & JBE EPROM Programmer & Parallel Interface) • 50 pin connector included in kit & assm.

80-153 ASSM. $110.95
Bare Board $49.95 Kit $ 89.95

SOLID STATE SWITCH



Your computer can control power to your printer, lights, stereo & any 120VAC appliances up to 720 watts (6 amps at 120VAC). Input 3 to 15VDC • 2-14MA TTL compatible • Isolation — 1500V • Non zero crossing • Comes in 1 or 4 channel version.

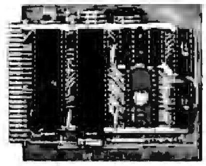
79-282-1 ASSM. $13.95
Bare Board $6.95 Kit $10.95
79-282-4 ASSM. $49.95
Bare Board $24.95 Kit $39.95

APPLE II DISPLAY BOARD

80-144 ASSM. $49.95
Bare Board $25.95 Kit $42.95

• Has run-stop, single step switch • Has 16 address LEDs, 8 data LEDs & 1 RDY LED • All lines are buffered.

Z80 MICROCOMPUTER



JBE's 4-1/8"x3-1/4" single board dedicated computer is designed for control functions. It features: • A Z80 Microprocessor software compatible with the Z80, 8080 & 8085 Microprocessors • Uses a Z80 PIO chip for I/O which has 2 independent 8 bit bidirectional peripheral interface ports with handshake & data transfer control • Uses one 2716 EPROM (2K) & two 2114 RAM memories (1K) • Single 5V power supply at 300MA req. • Clock frequency is 2MHz, RC controlled • Board comes with complete doc. • 50 pin connector is included • 2716 EPROM available separately.

80-280 ASSM. $129.95
Bare Board $49.95 Kit $119.95

PRINTER INTERFACE

JBE Parallel Printer Interface interfaces your Apple II® to Centronics® compatible printers. This 3" x 4" board features: on board ROM compatible with Integer Basic, Applesoft® and Pascal® • Has one 8 bit parallel latched output port with selectable positive or negative strobe and one bit input selectable for Ready or Ready • Cable and Connectors available separately.

80-297 ASSM. $79.95
Kit $69.95
4 ft. Std. Dip Jumpers 16 pin $ 4.25
Champ Connector $ 9.95

POWER SUPPLIES

• Use wall transformers for safety • Protected against short circuit and thermal breakdown.

5 VOLT POWER SUPPLY

Rated at 5V 500MA • Operates JBE A-D & D-A Converter, Z80 & 6502 Microcomputers, 8085 & 8088 Microcomputers.

80-160 ASSM. $20.95
Bare Board $8.95 Kit $16.95

± 12 VOLT POWER SUPPLY

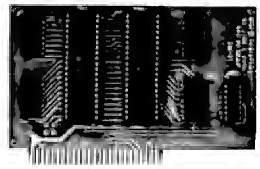
Rated at ± 12V 120MA • Can be used as a single 24V power supply • Ideally suited to OP-AMP experiments.

80-161 ASSM. $22.95
Bare Board $8.95 Kit $18.95

ICS

6502	$9.95
6522	$9.95
Z80 CPU	$9.95
Z80 PIO	$9.95
2716	$14.95
2716 Programmed	$19.95

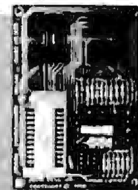
6522 APPLE II INTERFACE



• Interfaces printers, synthesizers, keyboards, JBE A-D & D-A Converter & Solid State Switches • Has handshaking logic, two 6522 VIAs & a 74LS05 for timing • Inputs & outputs are TTL compatible.

79-295 ASSM. $69.95
Bare Board $39.95 Kit $59.95

2716 EPROM PROGRAMMER



JBE 2716 EPROM Programmer was designed to program 5V 2716 EPROMS • It can also read 2716s. It interfaces to the Apple II using JBE Parallel I/O Card & four ribbon cable connectors • An LED indicates when power is being applied to the EPROM • A textool zero insertion force socket is used for the EPROM • Comes with complete doc. for writing and reading in the Apple II or Apple II+ • Cables available separately.

80-244 ASSM. $49.95
Bare Board $24.95 Kit $39.95
2 Ft. Ribbon Cable $ 4.25

BARE BOARDS

APPLE II EXTENDER BOARD

3½" x 2½". Price includes 50 pin Connector.

80-143 $12.95

8085 3 CHIP SYSTEM

State-of-the-art system using an 8085, 8156 & either an 8355 or 8755 • Instruction set 100% upward compatible with 8080A.

Bare Board $24.95

8088 5 CHIP SYSTEM

An 8086 family microcomputer system using an 8088 CPU, 8284, 8155, 8755A & an 8185.

Bare Board $29.95

CRT CONTROLLER

This intelligent CRT Controller uses an 8085A CPU & an 8275 Integrated CRT Controller. It features: • 25 lines (80 Char./line) • 5x7 dot matrix • Upper & lower case • two 2716s (controller & char. generator) • serial interface RS232 & TTL • baud rates of 110, 150, 300, 600, 1200, 2400, 4800 & 9600 • keyboard scanning system • unencoded keyboard is req'd • uses +5V & ± 12V power supplies • Doc. includes program listing & composite video circuit.

Bare Board only (Doc. incl.) $39.95
Programmed 2716s each $19.95

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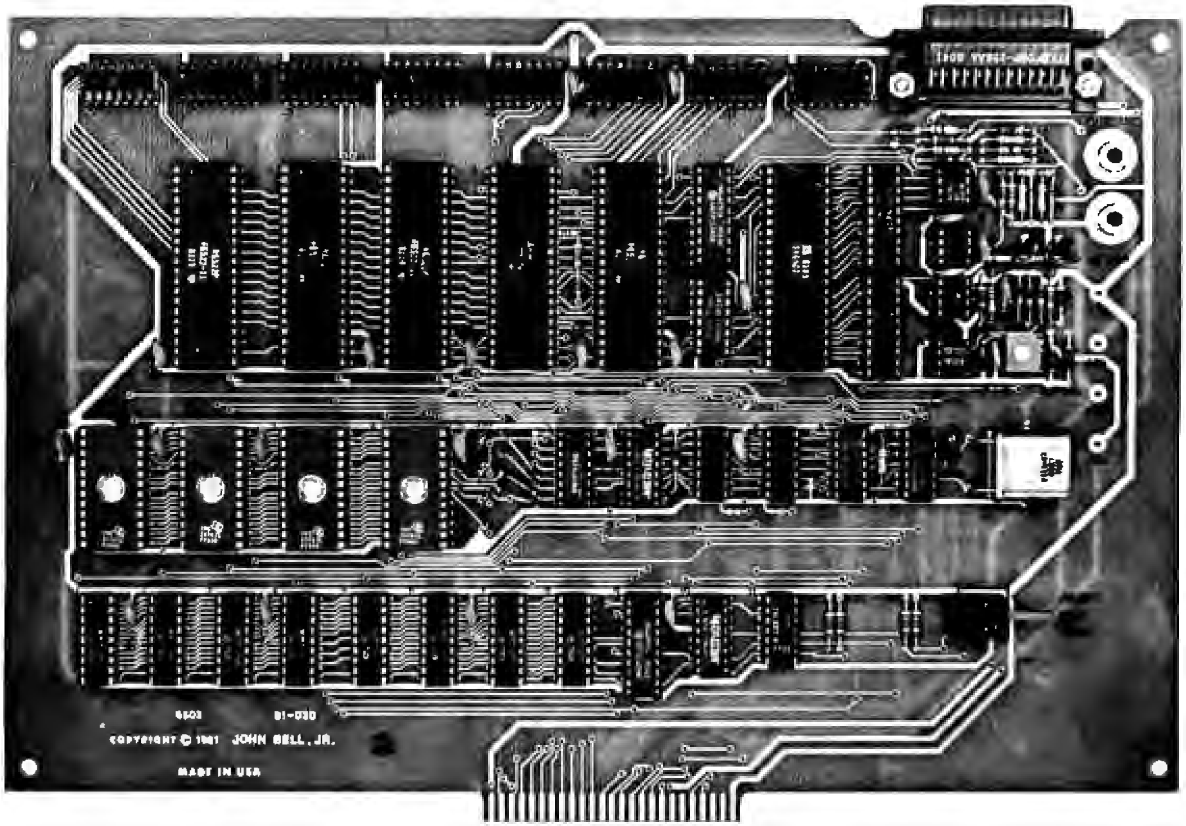

7400

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	.89	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	.38	SN74191N	1.25
SN7430N	.25	SN74116N	1.95	SN74192N	.89
SN7432N	.29	SN74121N	.38	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	.69	SN74136N	.75	SN74199N	1.49
SN7443N	1.10	SN74141N	.99	SN74221N	1.35
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	74LS92	.75	74LS192	1.15
74LS01	.29	74LS93	.75	74LS193	1.15
74LS02	.29	74LS95	.99	74LS194	1.15
74LS03	.29	74LS96	1.15	74LS195	1.15
74LS04	.35	74LS107	.45	74LS197	1.19
74LS05	.35	74LS109	.45	74LS221	1.19
74LS08	.35	74LS112	.45	74LS240	1.49
74LS09	.35	74LS113	.49	74LS241	1.49
74LS10	.35	74LS114	.49	74LS242	1.49
74LS11	.39	74LS122	.89	74LS243	1.49
74LS12	.35	74LS123	1.25	74LS244	1.49
74LS13	.59	74LS125	.59	74LS245	2.95
74LS14	.99	74LS126	.59	74LS247	1.19
74LS15	.35	74LS132	.99	74LS248	1.19
74LS20	.35	74LS133	.89	74LS249	1.19
74LS21	.35	74LS136	.49	74LS251	.99
74LS22	.35	74LS138	.89	74LS253	.99
74LS26	.35	74LS139	.89	74LS257	.89
74LS27	.35	74LS151	.89	74LS258	.69
74LS28	.35	74LS153	.99	74LS260	.69
74LS30	.35	74LS154	1.75	74LS266	.69
74LS32	.35	74LS155	.89	74LS273	1.95
74LS33	.59	74LS156	.89	74LS279	.89
74LS37	.45	74LS157	.89	74LS283	.89
74LS38	.39	74LS158	.89	74LS290	.99
74LS40	.35	74LS160	1.15	74LS293	.99
74LS42	.89	74LS161	1.15	74LS298	1.25
74LS47	.89	74LS162	1.15	74LS352	1.29
74LS48	1.15	74LS163	1.15	74LS353	1.29
74LS49	1.15	74LS164	1.15	74LS365	.69
74LS51	.35	74LS165	1.15	74LS366	.69
74LS54	.35	74LS168	1.19	74LS367	.69
74LS55	.35	74LS169	1.19	74LS368	.69
74LS73	.45	74LS170	1.95	74LS373	1.95
74LS74	.45	74LS173	.99	74LS374	1.95
74LS75	.59	74LS174	.99	74LS375	.89
74LS76	.45	74LS175	.99	74LS386	.69
74LS78	.49	74LS181	2.95	74LS393	2.49
74LS83	.89	74LS190	1.25	74LS399	2.49
74LS85	1.25	74LS191	1.25	74LS670	2.49
74LS86	.49			81LS95	1.95
74LS90	.69			81LS97	1.95

74S

74S00	.45			74S243	3.25
74S02	.45			74S244	3.25
74S03	.45	74S124	2.95	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
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74S22	.45	74S153	1.35	74S374	3.49
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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	1.25	74S941	3.15

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CD4009	.45	CD4043	.89	CD4511	1.29
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CD4013	.45	CD4048	1.39	CD4516	1.49
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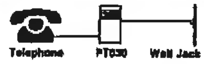
Phone Tunes

As Seen on "Good Morning America"
Replaces the Telephone Ringer Bell with a Selection of 30 Familiar Tunes



Each Unit will play any of the following tunes:

- Rule Brittania
- O Canada
- Colonel Bogey
- Westminster Chimes
- Mexican Hat Dance
- Twinkle, Twinkle Little Star
- Deutschlandlied
- God Save the Queen
- Close Encounters
- Happy Birthday
- Wedding March
- Jingle Bells
- Auld Lang Syne
- Soldiers Chorus
- Sailor's Hornpipe
- Charge!
- Greensleeves
- Lorelei
- Eyes of Texas
- Star Spangled Banner
- Oranges and Lemons
- Whiffenpoof
- Mozart Sonata
- Pomp & Circumstance
- William Tell Overture
- Bach Toccata in D Minor
- Shave and a Haircut
- Blue Danube Waltz
- Beethoven's 5th
- La Marseillaise

FEATURES

Replaces monotonous telephone ringer bell. Easily connects to any standard telephone. Can be used alongside regular phone or replace a remote ringer elsewhere in building or outside. FCC approved. Can be used on any telephone system — worldwide. Use a different tune to identify extension phones. Microprocessor controlled. Adjustable volume control and variable tune speed control. Operates on two 9-volt batteries or AC Adapter (not included).

PT030 Phone Tunes $49.95
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DISCRETE LEDS

XC556R	.200"	red	5/$1	MV50	.085"	red	6/$1
XC556G	.200"	green	4/$1	XC209R	.125"	red	5/$1
XC556Y	.200"	yellow	4/$1	XC209G	.125"	green	4/$1
XC556C	.200"	clear	4/$1	XC209Y	.125"	yellow	4/$1
XC22R	.200"	red	5/$1	XC526R	.185"	red	5/$1
XC22G	.200"	green	4/$1	XC526G	.185"	green	4/$1
XC22Y	.200"	yellow	4/$1	XC526Y	.185"	yellow	4/$1
MV108	.170"	red	4/$1	XC526C	.185"	clear	4/$1

.200(T1¾) Red/Green

Diffused Bi-Color LED

Part No.	1-99	100+
XC5401	.79	.69

XC556 RED LED, METAL MTG. HDW. 3-4" LEADS.
RL-2 . . $.39 ea. or 3/$1.00

DISPLAY LEDS

C.A. — Common Anode
D.D. — Double Digit
C.C. — Common Cathode
RHD — Right Hand Decimal

Type	Polarity	Ht	Price	Type	Polarity	Ht	Price
MAN 1	C.A.—red	.270	2.95	DLG507	C.A.—green	.500	1.25
MAN 2	5x7 D.M.—red	.300	4.95	DL704	C.C.—red	.300	1.25
MAN 3	C.C.—red	.125	.25	DL707	C.A.—red	.300	1.25
MAN 52	C.A.—green	.300	.99	DL728	C.C.—red	.500	1.49
MAN 54	C.C.—green	.300	.99	DL741	C.A.—red	.600	1.25
MAN 71	C.A.—red	.300	.75	DL747	C.A.—red	.600	1.49
MAN 72	C.A.—red	.300	.75	DL750	C.C.—red	.600	1.49
MAN 74	C.C.—red	.300	1.25	DLO847	C.A.—orange	.800	1.49
MAN 82	C.A.—yellow	.300	.49	DLO850	C.C.—orange	.800	1.49
MAN 84	C.C.—yellow	.300	.99	DL338	C.C.—red	.110	.35
MAN 3620	C.A.—orange	.300	.49	FND358	C.C. ± 1	.357	.99
MAN 3630	C.A.—orange ± 1	.300	.99	FND357	C.C.	.357	.75
MAN 3640	C.C.—orange	.300	.99	FND500	C.C. (FND503)	.500	.99
MAN 4610	C.A.—orange	.400	.99	FND507	C.A. (FND510)	.500	.99
MAN 6610	C.A.—orange—DD	.560	.99	HDSP-3401	C.A.—red	.800	1.50
MAN 6630	C.A.—orange ± 1	.560	.99	HDSP-3403	C.C.—red	.800	1.50
MAN 6640	C.C.—orange—DD	.560	.99	HDSP-3406	C.C. red ± 1	.800	1.50
MAN 6650	C.C.—orange ± 1	.560	.99	5082-7751	C.A., R.H.D.—red	.430	1.25
MAN 6660	C.A.—orange	.560	.99	5082-7760	C.C., R.H.D.—red	.430	1.25
MAN 6710	C.A.—red—DD	.560	.99	5082-7300	4x7 Numeric (RHD)	.600	22.00
MAN 6740	C.C.—red—DD	.560	.99	5082-7302	4x7 Numeric (LHD)	.600	22.00
MAN 6750	C.C.—red ± 1	.560	.99	5082-7340	4x7 Hxdcl. (0-9/A-F)	.600	22.50
DLO304	C.C.—orange	.300	1.25	4N28	Photo Xsistor Opto-Isol.		.69
DLO307	C.A.—orange	.300	1.25	LIT-1	Photo Xsistor Opto-Isol.		.69
DLG500	C.C.—green	.500	1.25	MOC3010	Optically Isol. Triac Driver		1.25

SOCKETS — RECEPTACLES

Test TEXTOOL Sockets

ZERO INSERTION FORCE

- Nickel Boron Plating
- G.F. PSF Plastic Body
- For testing IC's

Part No.	Pins	Price	Part No.	Pins	Price
214-3339	14 pin	5.95	222-3343	22 pin	9.95
216-3340	16 pin	6.49	224-3344	24 pin	9.75
218-3341	18 pin	7.95	228-3345	28 pin	11.95
220-3342	20 pin	8.96	240-3346	40 pin	12.95

- Nickel Boron Plating
- G.F. PSF Plastic Body
- Wire Wrap Contacts

Part No.	Pins	Price	Part No.	Pins	Price
214-3592	14 pin	9.75	222-3596	22 pin	12.95
216-3593	16 pin	9.95	224-3597	24 pin	12.75
218-3594	18 pin	10.95	228-3598	28 pin	13.95
220-3595	20 pin	11.95	240-3599	40 pin	15.95

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	1.36	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
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ASST. 2	5ea.	68 Ohm 180 Ohm	82 Ohm 220 Ohm	100 Ohm 270 Ohm	120 Ohm 330 Ohm	150 Ohm 390 Ohm	50pcs.	$1.95
ASST. 3	5ea.	470 Ohm 1.2K	560 Ohm 1.5K	680 Ohm 1.8K	820 Ohm 2.2K	1K 2.7K	50pcs.	$1.95
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ASST. 5	5ea.	22K 56K	27K 68K	33K 82K	39K 100K	47K 120K	50pcs.	$1.95
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ASST. 7	5ea.	1M 2.7M	1.2M 3.3M	1.5M 3.9M	1.8M 4.7M	2.2M 5.6M	50pcs.	$1.95
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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.	16.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
7201IDR	Low Battery Volt Indicator	2.25
7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	18.95
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	12.95
7207AIPD	Oscillator Controller	6.50
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7208IPI	Seven Decade Counter	17.95
7209IPA	Clock Generator	3.95
7215IPG	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL	19.95
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7216CIJI	8-Digit Freq. Counter C.A.	26.95
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7224IPL	LCD 4½ Digit Up Counter DRI	11.25
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7555IPA	CMOS 555 Timer (8 pin)	1.45
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7611BCPA	CMOS Op Amp Comparator 5MV	2.25
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7631CCPE	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
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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
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74C

74C00	.39			74C221	1.95
74C02	.39	74C95	1.59	74C240	2.25
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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	1.69	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
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74C86	.99	74C175	1.19	74C925	7.50
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74C90	1.29	74C193	1.69	80C95	.79
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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
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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
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LM310CN	1.75	LM373N	3.25	LM1871N	5.49
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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
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LM320T-12	1.25	TL494CN	4.49	LM3909N	1.15
LM320T-15	1.25	TL496CP	1.75	LM3914N	3.95
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LM340K-12	1.35	LM567V	1.25	75451CN	.39
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50 VOLT CERAMIC DISC CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
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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

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.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

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.15/35V	.39	.34	.29	2.2/35V	.51	.46	.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	.58
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1.0/35V	.39	.34	.29	22/6V	.79	.69	.55

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1.0/50V	.16	.14	.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	.16
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 212 on inquiry card.

Circle 212 on inquiry card.

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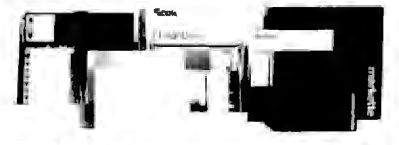

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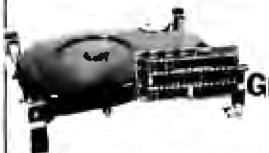

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4044-2	250ns	5.50	4.95	4.50	4.35
5257-3	300ns	4.47	4.25	4.05	3.75

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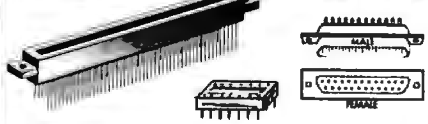

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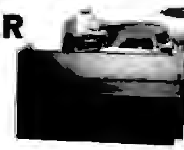
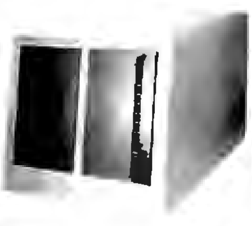


NEW from *Shugart Technology* 5 Megabyte Hard Disk Drive



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FOR SALE: Technico Super Starter System (9900 processor) with schematic, SwTPC keyboard, Phi-Deck variable speed, control board, remote-control box, digital head, and power supply. Full documentation on them all. Looking for Sinclair ZX80 or PET (trade?). Paul Bergson, 1413 N 11th St, Superior WI 54880, (715) 394-3101

WANTED: TRS-80 Model II with read-only memory, expansion interface, disk drive(s), etc. R J Carlson, 1210 46 Ave, Meridian MS 39301, (601) 483-2459.

FOR SALE: Xerox 1730 (Diablo 6630) letter-quality printer with adjustable forms tractor and Televideo 912C video display. Both five months old and used only for a brief testing period. $2750 or best offer. Steven Gelles, 112-41 72 Rd, Forest Hills NY 11375, (212) 544-7030 evenings.

FOR SALE: TRS-80 16 K Level II: all components (processor, monitor, cassette, power supply, cables), line filter, manuals, over thirty programs (EDTASM, games, utilities), and books and magazines related to TRS-80s. All in perfect condition (original Radio Shack seal intact). Original value over $1000, sacrifice for $600 plus shipping. Albert M Berg, 1914 Ave O, Brooklyn NY 11230, (212) 645-2397.

WANTED: Documentation for Processor Technology NKRA 64 K dynamic programmable-memory board. I need assembly instructions, schematic, and parts list. Please send a copy or I can copy and return your original. Michael Schirpke, 8 Champa Rd, Billerica MA 01821.

FOR SALE: 1802 system, including Netronics 4 K programmable memory, Giant Board, processor board, 1702 and 2708 EPROM board, SN76477N music board, two A-Ds, five extra I/Os, Hex-Dec decoder, address display, and processor status. Software includes CHIP-8, T BASIC, plus material from RCA, Quest, and Netronics. All for $300. T Constable, 130E 24th St, New York NY 10010, (212) 533-5163 evenings.

WANTED: College student interested in computer experimentation. Due to limited funds, I would like information concerning used or discarded computer equipment and/or parts. If you have such, please send me your name and address with a list of the equipment. John M Hall, 1445 Royalwyn Dr, Box 602 LWW, Macon GA 31210.

FOR SALE: Over 1000 boards from IBM System 1140 computer. All with gold-plated edge-connector pads. All boards loaded with parts. Other miscellaneous parts include edge connectors and card guides. Offers? Ken Cazakoff, RR #2, Bedford Rd, Nelson British Columbia, V1L 5P5 Canada, (604) 352-3898.

FOR SALE: Compucolor II Model 4 computer with 103-key keyboard. Cost $2000, will sell for $1300. Also, Olivetti teleprinter for $300. Robert Meader, 17721 140 NE, Woodinville WA 98072, (206) 483-8600 days.

FOR SALE: SwTPC 6800 processor board, motherboard, 4 K programmable-memory board, 16 K programmable-memory board, MP-C serial board, parallel board, ACIA board, front-panel display, MIKBUG monitor, TSC BASIC, and Siemens 5-inch floppy disk. $750, you pay UPS. Will ship COD. Steve Griffith, POB 791, Safford AZ 85546.

FOR SALE: OSI C4P-DMF computer with 48 K programmable memory and dual minifloppies. Includes color monitor, printer, modem, and joysticks. Includes the following languages: BASIC, Pascal, FORTRAN, FORTH, and assembly. Extensive documentation and over 200 software programs. Excellent condition. Cost almost $6000, sell for $2000. Kevin Mucha, 10445 W Kiehnau Ave, Milwaukee WI 53224, (414) 353-3683.

FOR SALE: 1-megabyte hard-disk drive with documentation and interface information. First $350 takes it. I pay shipping. KSR35 ASCII Teletype. Excellent hard copy for Apple, TRS-80, etc. $300 plus shipping. Would like to buy the following: Cromemco Z-2 system, 64 K S-100 memory board with 16 K or less memory, I/O Selectric Heuristics Speechlab, Computalker speech-synthesis board. All letters answered same day. Fred Aker, Farmers Way, Carlsbad Springs Ontario, K0A 1K0 Canada, (613) 822-1443.

FOR SALE: TRS-80 Model I, Level I computer with 4 K programmable memory. Includes video screen and recorder. In very good condition. Comes with books, manual, software, and graphics sheets. Am asking $325 and will pay shipping cost anywhere in the continental US. Ron Campbell, 412 Woodley Rd, Savannah GA 31406, (912) 925-6524.

FOR SALE: New Intel SBC 86/12A 16-bit, single-board computer with 32 K dynamic programmable memory, RS-232 serial port, three parallel data ports, PIC, and interval timer. Also includes schematics and documentation. List $2600. Asking $1300 or best offer. Helmars Ozolins, 59 Hageman Landing Rd, Rocky Point NY 11778, (516) 744-4204 after 6.

FOR SALE: Cleaned out ham/computer/electronics shack. Have two-page list of amateur radio equipment, automotive electronics, tools, scanner, paraphernalia; you name it, it might be there. All items for sale or trade, and purchasing list is included. SASE would be appreciated. Dave Miller, POB 9684, Birmingham AL 35215.

FOR SALE: 8 K PET with joystick, light pen, sound, RS-232 output, and seventy cassettes; $900. First ten issues of BYTE; $15. Bruce Beebe, 2580 E 2100 South, Salt Lake City UT 84109, (801) 584-1287.

WANTED: Schematic and parts list for a SEAL 32 K SC memory bare board. Will pay reasonable reproduction costs plus postage. G S Meader, Jr, 1601 Greenbrier Ct, Reston VA 22090.

WANTED: The MEI (Merlin Extended Intelligence) read-only memory and manual for the Mini Term Associates Merlin Board. I need a listing of the software, the instruction manual for the software, and the 8316 mask read-only memory or a 2716 with the software or a Tarbell formatted cassette with the software. Dave Lamb, 3501 Kingston Cir, Ft Collins CO 80525, (303) 223-7131 collect.

FOR SALE: Expandor Black Box (Mite) printer: 80-column, 10 cps, parallel I/F, friction/pin feed, and uses teletypewriter ribbons. Has seen light service, in very good condition. Runs on Sphere and TRS-80 processors. Manual included. Cost $450, asking $250. Chuck, (303) 986-9027 after 7 PM MT.

FOR SALE: Complete set of Popular Electronics from first issue (1954) to 1980; $200. Also, various model-aircraft magazines, and assorted Scientific Americans. Send for full list. Bill Schweber, JAFFA Engineering, POB 543, Sharon MA 02067.

WANTED: Back issues of OMNI magazine in mint condition. William Blair III, 909 E Emerson, Morton IL 61550.

FOR SALE: H-8 computer, one year old. Recently configured for O-origin CP/M 2.2. Includes H-17 dual disk drive and controller card, Trionyx 64 K memory, and WH 8-4 4-port interface equipped with three RS-232 rear-panel D connectors. Complete documentation and $600 worth of software, including CP/M 2.2, MAC, SID, FORTRAN 80, and space game. Best offer will be accepted and will ship at no charge anywhere in the US. Dennis Crouse, 125 Conant Rd, Melrose MA 02176, (617) 964-8360 between 9 AM and 5 PM, call collect.

FOR SALE: Heathkit ET-3400 microprocessor trainer, ETA-3400 interface, and EE-3401 training course. Expertly constructed. Make offer. Doug DePrenger, 7800 Mockingbird Ln #139, Ft Worth TX 76180, (817) 485-2904 evenings.

COLOR PROGRAMS: Games, applications, and educational programs on cassette for the TRS-80 Color computer. Will trade for other original programs (or homebrew hardware designs) for the same machine. Send tape or information with your address and I will send my programs by return airmail. S W Li, 154 Curzon St, Toronto Ontario, M4M 3B5 Canada.

FOR SALE: KIM single-board computer, George Risk keyboard, and XITEX SCT-100 terminal board with power supply plus video monitor. Package includes documentation for keyboard, terminal board, and monitor. Also included are several KIM manuals. Everything works perfectly. $600 package, first offer over $250 takes it. Sue Livingston, 601 Pinchot Ave, Madison WI 53716, (608) 221-8431 evenings.

FOR SALE: S-100 boards removed from operating system. Documentation and shipping included. Ithaca Audio Z80 processor board, 4 MHz without read-only memory; $150. WMC FPB-1 front-panel board; $100. DRC 8 K 200 ns static programmable-memory board; $100. Electronic Systems TID-MA with system-monitor cassette; $80. California Digital motherboard with eight connectors installed; $45. Sunny International T3 transformer with capacitors; $40. WMC IOB-1, 2P + 1S ports bare board; $20. BYTE issues 1, 2, 3; best offer. John Fliegel, 112 Timberwood Dr, Mars PA 16046.

FOR SALE: TI-99/4 computer in excellent condition, with joysticks, tape recorder, large program library, light pen, three command modules, 16 K programmable memory, and 24 K read-only memory. $699 or make offer. David Rockower, (714) 456-0861.

FOR SALE: OT SBC + 2/4 processor board; $150 or best offer. TV interface from Electronic Systems part #107A; $10. Both boards are assembled and include complete documentation. Stephen Belisle, 701 Cavu Rd, Georgetown TX 78626, (512) 863-6205.

WANTED: Prisoner wants to write to pen pals with shared interests: computers, digital electronics, calculus, and Fibonacci numbers. Please use SASE. Kearney, B-88913, San Quentin CA 94974.

FOR SALE: California Computer Systems parallel interface Model 7720B, complete with cable and sockets for interfacing between an Apple II and an IDS 460 printer. I could not figure out how to write software patches to allow the interface to run the printer. The hardware is in mint condition. $80 will deliver the items plus manual. John Kundrat, 1622 21st St, Lewiston ID 83501, (208) 746-3487

FOR SALE: Heath H-8/48 K (16 Trionyx, 32 Heath) 4-port and H8-5 serial with dual Heath cassette, H-9 video display with 24 lines uppercase/lowercase. All for $888. Also, WH-14 printer; $555. R Jackson, 201 Mortimer Ave, Rutherford NJ 07070, (201) 939-2421

WANTED: Original IMSAI 8080 system. Looking for mainframe with at least six connectors, 28 A power supply, original front panel, MPU-A 8080 processor board, SIO 2-2 interface board, approximately 16 K of memory, and all necessary documentation. Keith Headley, 1161 Statler St, San Pedro CA 90731.

FOR SALE: DC 300A tape cartridges. I have six, mixed brands, that were used for archival storage. I have no way of checking them, but all should be good. Make offer for all six. If you don't get at least three good ones, refund guaranteed. A W Du Rea, 101 Indian Ln, Oak Ridge TN 37830

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BOMB

BYTE's Ongoing Monitor Box

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Ciarcia Controls August BOMB

Steve Ciarcia cops first place again with the second part of his article, "Build a Z8-Based Control Computer with BASIC." Steve will, of course, receive the $100 purse. Second place goes to Stan Miastkowski for his report on "The Japanese Computer Invasion." (As a staff member, he is not eligible for the $50 prize.) Third place goes to Adele Goldberg for her article, "Introducing the Smalltalk-80 System," an overview of the theme of BYTE's annual language issue.

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